



**IAMU 2013 Research Project**  
(No. 2013-3)

**Maritime Safety and Security**  
**MARSA – Enhancing Safety Awareness**  
**of the Maritime Personnel**

By

Constanta Maritime University (CMU)

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## **Maritime Safety and Security**

### **MARSA – Enhancing Safety Awareness of the Maritime Personnel**

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And

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***Abstract:*** During past years, the maritime industry faced numerous changes and challenges. Most of these, generated new requirements in levels of knowledge and understanding for the personnel involved in the field, especially for those at management level. Safety of maritime activities is one of the areas affected by increasing complexity and need of new knowledge. A very important aspect of the training process is to increase the awareness of the personnel in relation with the new challenges. For this, the institutions implicated in training have the duty to develop and offer qualified courses that cover latest requirements. Constanta Maritime University and Varna Naval Academy have decided to develop a Master program dedicated to enhancing of maritime personnel awareness in safety matters. This program was developed with the support of IAMU and The Nippon Foundation in Japan. In the present paper are presented the objectives and goals of the project entitled “MARSA – Enhancing Safety Awareness of Maritime Personnel” and the way these objectives were acquired through the developed teaching materials and evaluation processes.

***Keyword:*** *Maritime industry, master degree, safety, security, awareness*

## 1. Introduction

The safety of life at sea, protection of the marine environment and over 90% of the world's trade depends today on the professionalism and competence of seafarers. The IMO's International Convention on Standard of Training, Certification and Watchkeeping for Seafarers (STCW), with all amendments made, is the only one internationally-agreed Convention that issues minimal standards of competence for seafarers, and, in the same time, provides effective mechanisms for enforcement of its provisions.

Safety on board ships has come a long way in reducing accidents, but there is still a lot of scope to improve safety. Most of the accidents at sea are due to human error, which can be reduced by proper training and motivation. Accidents mainly happen due to lack of management, taking shortcuts, complacency, attitudes, etc. The responsibilities to avoid incidents based on safety and security flow from the top management levels, from the shore establishment to onboard management officers, especially to the Master, to each and every individual onboard.

The dynamic nature of the regulatory environment for safety and security in the international trade and maritime transport requires that personnel involved is capable to maintain an active awareness of new or evolving requirements that may apply to their vessels and operations. This means being able to integrate the latest requirements into their existing security plans, to achieve the desired level of compliance with the letter and intent of the new regulations. In this way, is required that personnel with duties on ship safety and security to maintain an awareness of changes or additions to the expanding universe of domestic and international regulations that may have an impact on their ability to maintain a safe and secure operating environment.

## 2. The “MARSA” Project objectives and goals

The complexity of modern maritime transport and the increasing risks related to safety and security lead to a significant challenge to maritime education. The growth of international maritime trade, combined with the increased threats on maritime safety and security, lead to the necessity of better trained personnel onboard ships, who would be able to manage these new situations and satisfy the highest levels of safety and security requirements on seas.

In line with this, the main goal of the proposed project was:

To develop a novel approaches for maritime academic safety and security programs that meet the requirements of modern maritime industry. The idea is to achieve the objective by developing a Master degree program in Maritime Safety and Security. Taking into account, on one hand, that maritime activity is international by nature, and on the other, that the IAMU goal is to develop a comprehensive Maritime Education System for following generations, the proposed Master degree program is to be established in cooperation between Constanta Maritime University (Romania) and "N. Vaptsarov" Naval Academy, Bulgaria.

Therefore, the project objectives were:

- I) To establish an international cooperation in the area of modern maritime education. The cooperation between maritime institutions is not completed by the involvement of two universities. The project relies on academic participation of a wide variety of representatives from the maritime community: maritime industry representatives, involved authorities, Black Sea maritime universities, IAMU members. In this context and taking into account the IAMU goal for preparing and developing standardized Undergraduate Curricula and an International Certification System for Competency, the following two additional projects objectives are valid:
- II) To establish a common understanding on the priorities of modern maritime education and a basis for common standards for maritime competency of the management personnel, especially with duties in ship safety and security;
- III) To enhance the cooperation and communication between maritime universities and maritime industry in the area of advanced maritime education and training.

The project objectives is to be achieved by the following tasks:

1. Elaboration of course materials for the proposed training program.  
First task of of the project was to complete the elaboration of course materials for the Master degree programme. This task was completed by the following activities:
  - 1.1. Elaboration of entire materials for the course entitled “Safety in maritime transport operations”.
  - 1.2. Elaboration of entire materials for the course entitled “Navigation safety”.
  - 1.3. Elaboration of entire materials for the course entitled “Risk based safety ”.
  - 1.4. Elaboration of entire materials for the course entitled “Special ships operations”.
  - 1.5. Elaboration of entire materials for the course entitled “Security awareness in piracy areas”.
2. Establishing the evaluation system and evaluation criterias of the programme according to international regulations and shipping industry requirements.
3. Evaluation of curricula and course materials in both universities involved in project.

The activities will be performed by a team of researchers from Constanta Maritime University and “N. Vaptsarov” Naval Academy. Additionally, representatives of shipping industry and specialist in problems related safety and security on sea will be engaged in this activity to express their opinion about the meeting of necessary requirements

Second task includes the following activities:

2.1. Establishing the evaluation system and criterias

2.2. Selection of participants to evaluation and schedule of evaluation process

The final task envisage contact supervision of the educational process, the appropriateness of the enlisted academic subjects and the effectiveness of lecturers' work. For completing of this task will be involved researchers, speciality lecturers and students from both universities. Students have the role to evaluate the programme from different points of view and to express their considerations about.



### 3. The aims and contents of the developed teaching materials

#### *3.1 Course no.1: Safety in maritime transport*

The first course of the Project was developed by lecturers from Constanta Maritime University and has the aims to prepare trainees to determine safety threats and solutions related to maritime transport operations. The course is planned to have 120 hours with 8 ECTS.

The course is focus on safety problems possible to take place during ship in port under operations or generated by the economical transactions which involve the ship.

This course will offer a better understanding of issues related to safety of maritime transport operations on the strategic, practical and operational level.

Having successfully completed the course, the student will be able to demonstrate knowledge and understanding of:

- ✓ Appreciation for the diversity of actors, challenges and opportunities involved maritime transport
- ✓ A formal analytical approach to a given maritime transportation problem from a safety improvement point of view
- ✓ The role of maritime transportation system and its function in a globalized world
- ✓ Key concepts and relationship between reliability, availability and safety of maritime systems
- ✓ Implementation and applying of the principles of safety management in maritime transport operations
- ✓ The importance to contribute to promote analytical approaches for safety improvement to the maritime transport industry
- ✓ Tools and methods for managing safety risks in maritime operations

Based on the competences that will be reached at the end of this course, the course content is structured according with the following description of the chapters.

**Introduction to safety of maritime operations.** Maritime, along with aviation, is considered a sensitive and of high-risk transport sector, in terms of safety and security. Moreover, topics related to safety in maritime transport have become very important over the past decades mostly because of the numerous maritime accidents putting in danger both human lives and the environment. Taking into account the global dimension of maritime transport along with the fact that the participation of Asia in the world trade during the past decade has been substantial, the current maritime safety and security practices apply for all areas. This can only be achieved through the application of high standards and regulations setting the prerequisites for safe and secure navigation.

Being a complex area, which covers many sector politics, there is no universal legal definition for the term “maritime safety”, but it is clearly admitted that this covers two areas as distinct as possible: the area of maritime security and the area of maritime safety. The elements of the maritime security area include: international peace and security, sovereignty/ territoriality and political integrity/independence, safety from maritime crimes, the security of resources, environmental security, and the security of maritime carriers and of maritime commercial ships. The elements of the maritime safety include: construction and equipment of ships, crew training and their working conditions, transport of goods and of passengers, safety of navigation and assistance in case of emergency situations.

Safe operation of the ship has many dimensions, but three are most important.

Firstly, the technical safety standards and “built-in” margins against accidents or failures.

Secondly, the additional safety barriers that are put in place against failure. These barriers may be against technical or operational failures.

Finally, the way in which we maintain the integrity of these barriers against failure over time.

The first dimension is mostly covered through class and statutory rules combined with other international standards. The second dimension has received less focus in the maritime field than in other industries. The third dimension is obvious, but often forgotten. Having safety barriers in place does not mean that they are effective over time. This has a lot to do with having the right competence and correct safety culture in place. Individuals, teams and organizations must act according to the highest standards every day, both onshore and shipboard, and never ever compromise on safety.

**Safety and the concept of safety.** Maritime safety aims to minimise the occurrence of accidents or near miss situations. An accident refers to a situation which results in some kind of damage or injury. Near miss is a hazardous event or situation where the sequence of events could have caused an accident if it had not been interrupted somehow.

Policy instruments are techniques used by governmental authorities for wielding their power in the attempt to ensure support and to effect or prevent social change. Authorities have two reasons for controlling the shipping industry. Firstly, of monopolies, secondly, protecting public goods such as clean air and water, nature or the climate must be done by the authorities as these cannot be regulated through the market and the market does not have incentives to protect or reduce the use of public goods.

There are many ways to categorise policy instruments. Several scholars have divided instruments into regulatory, economic and information instruments. These three types were characterised as carrots, sticks and sermons. This is because being based on actors' behaviour, actors can be addressed to rewards (carrots) such as subsidies, sticks such as charges and sermons, which can impact the behaviour of some groups of actors but cannot force actors to do anything. In addition to guiding the operations of the private sector, maritime safety policy instruments provide a framework for the work of the public sector, which is responsible for providing infrastructure for safe shipping.

Regulatory instruments aim to modify actors' behaviour by defining or changing the sets of rules. Regulatory instruments are mostly command and control instruments which establish legally binding rules that define goals and the manner of achieving these goals.

Economic instruments make certain actions cheaper or more expensive in terms of money, time, effort or other valuables. Economic instruments, which are also called market-based instruments, involve handing out or taking away material, monetary or other resources so that companies would have an economic incentive to change their activities towards the desired behaviour.

Information instruments are based on the idea that shared information makes individuals, communities and companies voluntarily change their behaviour patterns towards the favourable. Information instruments use plain knowledge, emotional persuasion, normative appeals and recommendations for action instead of incentives and penalties.

Maritime transport companies' voluntary activities have the potential to improve maritime safety in the future. These activities can be considered as corporate social responsibility, which at simplest signifies the companies' voluntary measures that go beyond laws.

**Risk and safety assessment in maritime operations.** Risk is a factor that everyone encounters in maritime operations. Decisions made everyday are based upon risk. Usually, decisions are intuitive in nature and rooted in common sense.

In the safety assessment process, safety can be described as a state in which the risks are at an acceptable level (or below the limit between acceptable and unacceptable). Thus, in order to be able to give a definition for safety it is useful to define first its counterpoint, risk. Risk is a word that can have many meanings. Risk is defined as a measure of the probability of a hazards related incident occurring, and the severity of harm or damage that could result. This harm can be directed to persons (crew/passengers/ others), environment (nature) and/or property (ships/port facilities/other). In some cases the harm may even affect the reputation. In practice it is impossible to completely prevent unwanted events completely, so the two approaches (risk and safety) are best used together.

There are several difficulties to observe safety, due to the fact that safety is not an easily observed a directly measurable state. Therefore, indirect measurements, risk assessments, are required for this purpose. Risk fundamentally involves uncertainty. Thus, it seems to be inevitable that some uncertainty is always involved with safety.

Concept of safety: *Failures will occur, in spite of the most accomplished prevention efforts. No human endeavour or human-made system can be free from risk and error. Controlled risk and error is acceptable in an inherently safe system. The elimination of accidents (and serious incidents) is unachievable. Failures will occur, in spite of the most accomplished prevention*

**Incident management in maritime transportation.** Studies have shown that many accidents are not the consequence of a major danger or hazard, nor do they happen due to missing safety regulations or safety equipment. A great number, if not the majority, of accidents happen as the consequence of minor lapses and usually of not just one lapse, but the sequence of minor failures. In the context of safety management systems, incident management has been one of the major triggers for improvement and changes. The objective was essentially this: something that has happened should never recur, and everything should be done to prevent accidents from repeating, to diminish the danger to which employees are exposed and to reduce the risk of operations.

Incidents today are not the consequence of major dangers, but rather the result of chains of minor lapses. The first step toward an improvement is, therefore, to gather all information about what is happening within the company—to collect information on every kind of hazard or safety-related misconduct.

One of the first steps when setting up proactive safety management is to define what kinds of incidents or occurrences are to be collected.

Incident management involves many stakeholders and aspects, from initial reporting to safety management to legal reporting. Any approach to setting up a successful incident management must take into consideration the whole range of stakeholders and aspects. An isolated approach is bound to fail. It is therefore a crucial prerequisite to analyze incident management in the overall context of environmental health and safety and in the context of internal and external dependencies, within the corporation and outside.

As mentioned, it is important for the design and setup of a proactive safety culture driven by a modern incident management system to analyze the dependencies and interdependencies within the greater picture of environmental health and safety, with all its facets. environmental health and safety has various centers of competence and activity; we might call them functional areas. And these functional areas, such as hazardous substance management, industrial hygiene, occupational health, environmental compliance and reporting and so on, have a great interdependency. Process flows across and information flows between these areas.

**The safety culture.** The concept of safety culture as a term and an explanatory factor in an accident investigation was first used by the International Atomic Energy Agency (IAEA) International Nuclear Safety Advisory Group (INSAG) following the Chernobyl accident that occurred on April 26, 1986. More recently, several diverse definitions of the safety culture concept have abounded in the safety research and organizational literature. In general, all the conceptual definitions can be placed in two broad categories: the socio-anthropological and the organizational psychology perspective. The concept of safety culture—and climate—has over time been a theme of heated discussion, with little theoretical consensus emerging on the ontological, epistemological, and methodological questions relating to the subject.

**Safety climate in maritime industry.** As with safety culture, no standard definition of safety climate exists. There is also confusion concerning the relationship and the differences between safety culture and safety climate. Consequently, the term safety climate is sometimes used interchangeably with the term safety culture. Perhaps one of the simplest explanations of safety climate is that it is not safety culture. One of the more common descriptions of safety climate is that it is a —snapshot of safety culture. This means that safety climate reflects the safety culture at a given time and place. In contrast to safety culture, safety climate often refers to the features and not to the deeper context. It can be considered that the organizational culture is expressing itself through the organizational climate.

The relationship between organizational culture and safety culture is not yet agreed on. Part of the reason for this is thought to be that there is a lack of theoretical background to the definition of safety culture presented by IAEA. While some researchers view safety culture as a part of the organizational culture others chooses to study the organizational culture’s impact on safety. One of them views safety culture as a part of the organizational culture which in turn is part of an industrial and a national culture. This framework for safety culture is though based on a framework of organizational culture that suggests that there is no need for a specific definition of safety culture. The basic assumptions of his framework are said to have an impact on safety, even if they are not explicitly related to safety, since they will permeate throughout the whole organization. Other researchers suggest the same approach where the organizational culture’s impact on safety is studied rather than safety culture.

Evaluating safety culture is complex, time consuming and requires the use of triangulated methods. Evaluating safety climate is much simpler than evaluating safety culture. The main reason for this is that it can be done by using only quantitative methods.

Safety at sea ranks highly in all assessments of risk, including vessel and cargo loss or damage, crew injuries or fatalities. According to UK P & I Club statistics, more than 53% of loss prevention claims made in recent years due to marine and port accidents, were attributable to human errors, of which, 21%, 16%, 11%, 4% and 2% were deck officer, crew, shore person, pilot, and engineering officer errors, respectively. An investigation of maritime accidents, likewise found over 56% of accidents resulted from human errors. Unsafe crew actions and physical, psychological, medical, workplace and environmental factors noticeably contributed to such accidents. Other studies and reports have also indicated that between 60% and 90% of all accidents can be attributed to the “human factor”.

The causes of crew fatality or vessel failure are not always clear. A recent study found successful injury control programs are based on strong management commitment to safety, the high status of safety officers within the organization, worker training, regular communication between management and workers, general housekeeping, and a stable workforce.

Moreover, an understanding of seafarers’ perceptions of safety climate and its relationship with vessel accidents in the shipping context is lacking.

**Emergency and emergency planning in maritime operation.** All ships and terminals should have procedures ready for immediate implementation in the event of an emergency. The procedures should cover all types of emergency that can be envisaged in the context of particular activities onboard or at terminal, for example fire, explosion and ill or injured persons. While the deployment of fire-fighting equipment is likely to be prominent in any emergency procedure, equipment such as breathing apparatus, resuscitation equipment, stretchers and means of escape or exit should also be covered. Sufficient manpower is necessary to initiate successfully and to then sustain any response plan. Therefore, a thorough study should be made to determine the total manpower requirements over the whole period of any emergency. Where appropriate, assistance may be obtained from local emergency organizations, nearby airports, industrial plants or military installations. However, it should be ensured that ship and terminal manpower is sufficient to mount an initial response to any emergency.

**Port regulations regarding safety.** The scale, nature and complexity of port operations and activities call for a set of specific rules, distinct from the general regulatory regime. These rules have to ensure the efficient functioning of the port as well as the safety and the security in the port area. They may also serve other purposes, such as the prevention of environmental pollution. Commonly, these specific rules take the form of port regulations, which may be defined as rules relating specifically to port operations and activities, prescribed by a competent authority and having the force of law. Port regulations include obligations and prohibitions, and frequently comprise provisions on their enforcement.

In the strict sense, port regulations are limited to rules of conduct adopted for the purpose of ensuring the safety, continuity and smoothness of port operations and activities in general (in some countries, these regulations are also called ‘general port regulations’, ‘port police regulations, or similar). The essence of port regulations seems to be that that they regulate the conduct of port users in general and that, as such, they serve the general interest of the port and its users.

**Safety of ship operations and maneuverings.** When under pilotage, the ship is exposed to higher risks and a pilot’s local knowledge should reduce these risks to an acceptable level. Numerous instances provide evidence that many incidents that occur during pilotage can be attributed to ineffective bridge resource management, and it is often the case that the master and watchkeepers cease to monitor the navigation and position of the ship after the pilot has boarded.

Careful management of the pilot is vital, and when the officers do not monitor the ship’s progress or the pilots’ actions, this often leads to a major incident. The attitude that the master and the officers can relax when there is a pilot on board must change; in fact, the bridge team should be in a higher state of alert

A number of high-cost incidents have occurred when the ship was leaving or arriving at a port and the pilot requested that he wanted to board the ship inbound of the pilot boarding station or disembark early before the ship reached the designated pilot station.

Also, ship towage is a vital service that needs to be properly reviewed, approved and regularly assessed. Harbour authorities need to develop systems to ensure continued safe and efficient towage services including the ability to respond to emergencies. These systems should be reviewed regularly in the light of experience, changes in legislation, tug technology and the operating environment. In developing these systems harbour authorities should seek to involve the relevant stakeholders including; the towage operators, pilots, berth operators, dock masters, boat men, vessel owners and operators

The prime consideration in developing these systems and policies should be to enhance the safety of those that operate in the port and to prevent accidents. Good communications and team work between towage operators and other stakeholders are essential to ensure efficient and safe operations.

Several cases have been reported in the past about accidents during mooring operations and many of them have led to severe injury or death of seamen. The worst case scenario is of course a crew member getting injured. Accidents always happen while you are unprepared, believing the operation to be going smoothly and efficiently. You think you are in control doing what you always do while mooring and suddenly you are in the middle of a situation you never thought was possible with a major crisis to be managed immediately and afterwards.

As humans we tend to believe that things are safe if nothing happens. You might say that the norm for what we believe is dangerous decreases over time. Normally mooring goes well, but as time goes by, the level of safety slowly declines. Maybe you lose concentration, maybe you slacken your procedures just a little bit, maybe you get a little complacent. And then it suddenly happens – not because of one factor but because of a number of interacting factors.

**Risk and safety precautions in dangerous cargo operations.** For years the maritime industry has been the main transport provider for moving dangerous goods from one port to another. Many governments realize that, if these goods are not managed safely and effectively it may pose hazards to the society and the environment. In November 1997, the IMO assembly adopted resolution A 852 (20) on “Guidelines for a structure of an integrated system of contingency planning for shipboard emergencies”. In accordance with the International Safety Management Code (SOLAS Chapter IX, 1994) all ships and the companies responsible for their operations, are required to maintain a Safety Management System. Most countries will have additional national and local regulations which require organizations to develop and maintain an emergency response plan covering their operations. To complement these emergency response requirements, the IMDG code Volume: Supplement contains guidance on Emergency Response Procedures for Ships Carrying Dangerous Goods. The supplement includes directions for dealing with incidents involving dangerous substances, materials or harmful substances (marine pollution) regulated under the IMDG Code.

Emergency response management: “*is the managerial function charged with creating the framework within which organizations reduce vulnerability to hazards and cope with disasters*”.

Regarding the operation of dangerous cargoes, the incidents can range from uncontrolled emissions and loss of containment to physicochemical effects such as fire and explosion, which can cause death, serious injury and large-scale damage to property and the surrounding environment. The term “risk” also assumes various meanings and it is used in different situations, senses and contexts by various people. The term is employed in many areas or activities, for example economic or financial risks, business risks, industrial risks, environmental risks, technical or operational risks, chemical risks etc. Risks are categorized in different ways, for example *voluntary and involuntary risks, statistically verifiable and non-verifiable risks, natural risks, technological and human activities risks.*

*Voluntary risks* are those associated with activities that people decide to undertake, for example, workers, stevedores or ship crews. *Involuntary risks* are those risks that are associated with activities that happen without prior consent or knowledge of, for example, members of public or community living adjacent to port or waterway areas. Acts of nature and exposure to environmental contaminants are examples of involuntary risks. Although exposed to involuntary risks, people may be aware of risks posed by dangerous goods related activities.

Risks are divided into *statistically verifiable and non-verifiable risks*. Statistically verifiable risks are risks that can be determined from direct observations. Hence, these risks can be compared with each

other. Generally, risks from dangerous goods are statistically verifiable or determined risks. Statistically non-verifiable risks are those risks that are assessed based on limited data sets and mathematical models, for example risks of rare natural phenomena.

Risks are also divided into *natural and human activities risks*, where the latter are known as *technological or man-made risks*. In the second category also fall risks of dangerous goods-related activities, including maritime transport. Risks also take on various meanings for these activities, for example business risks, i.e. speculative risks arising from an enterprise.

Risks of accidents involving dangerous goods are concerning issues for many countries and regions in the world. Transport of dangerous goods is a risk generator entailing possibilities of undesired outcomes. Due to releases of dangerous goods, transport poses considerable threats to the public safety and health and to the environment. However, technological and human activity risks should not be judged in isolation from the related benefits of these activities.

Risks to society (known as *societal risk or collective risks*) are defined as the relation between the frequency and consequences, which is the number of people suffering from a specified level of harm in a given population from the realization of specified hazards. Compared to individual risks, the concept of societal risks is broader and much more complex. These risks may cover many situations and affect the population of a country or a region as a whole. The concept of societal risks is particularly important when considering the potential of events associated with hazardous activities that result in large numbers of fatalities and injuries. One example of such activities is the maritime transport of dangerous cargoes. In Europe, the concept of societal risks is extended to account for environmental damage as well.

The marine (aquatic, ecosystem) environment is also exposed to marine accidents involving dangerous goods. Many risk studies have been confined to assessment of immediate effects of dangerous goods hazards to human safety and health. Assessments of the marine environment risks have been confined to major spills of a limited number of dangerous substances and materials carried in large quantities in bulk by sea, in particular oil, oil products and a few chemicals. Knowledge about the environmental risks from a wide range of different types of dangerous cargoes carriage water is underdeveloped.

**Safety of liquefied oil and gas operations.** All ships specialized in carriage of liquefied oil and gas, are designed so that, in normal operation, personnel should never be exposed to the hazards posed by the products being carried. This assumes, of course, that the ship and its equipment are maintained properly and that operating instructions are followed. In the event of accidental leakage, emergency inspections or maintenance tasks, personnel may be exposed to liquid or gaseous product. The risks of flammability, low temperature and asphyxia apply to nearly all liquefied gas cargoes. However, the hazard of toxicity and chemical burns apply to only some of them.

Effective emergency response requires an emergency organization round which detailed procedures may be developed. The international character of ocean shipping and its universally similar command structures lend themselves to the development of a standard approach in ships' emergency planning. For gas carriers this broad uniformity can be extended further to the development of incident planning. Such standardization is of advantage since ships' personnel generally do not continuously serve on the same ship. It is also of advantage in the handling of incidents in port in that terminal emergency planning can be more effective if there is knowledge of the procedures a ship is likely to follow.

**Safety of dry bulk cargo operations.** Bulk carriers were developed in the 1950s to carry large quantities of non-packed commodities such as grains, coal and iron ore. Some 5,000 bulk carriers trade around the world, providing a crucial service to world commodities' transportation. Bulk carrier

operators must be aware of the specific safety concerns related to this type of ship. Loading of cargo must be done carefully, to ensure cargo cannot shift during a voyage leading to stability problems. Large hatch covers must be watertight and secure.

The International Maritime Solid Bulk Cargoes Code (IMSBC Code), and amendments to SOLAS chapter VI to make the Code mandatory, were adopted by the Maritime Safety Committee (MSC), 85th session, in 2008. The IMSBC Code will replace the Code of Safe Practice for Solid Bulk Cargoes (BC Code), which was first adopted as a recommendatory code in 1965 and has been updated at regular intervals since then. The aim of the mandatory IMSBC Code is to facilitate the safe stowage and shipment of solid bulk cargoes by providing information on the dangers associated with the shipment of certain types of cargo and instructions on the appropriate procedures to be adopted.

The international Code of Safe Practice for Solid Bulk Cargoes (BC Code) includes recommendations to Governments, ship operators and shipmasters. Its aim is to bring to the attention of those concerned an internationally-accepted method of dealing with the hazards to safety which may be encountered when carrying cargo in bulk.

The loading or unloading plan shall be prepared in the form laid down in Appendix 2 of the BLU Code. The plan shall contain the IMO number of the bulk carrier concerned, and the master and the terminal representative shall confirm their agreement to the plan by signing it.

Any change to the plan, which according to either party may affect the safety of the vessel or crew, shall be prepared, accepted and agreed by both parties in the form of a revised plan.

The agreed loading or unloading plan and any subsequent agreed revisions shall be kept by the ship and the terminal for a period of six months for the purpose of any necessary verification by the competent authorities.

**Reliability and safety of maritime systems.** The focus on reliability engineering is with respect to its role within the current developments of system safety and risk analysis. The focus on the problems and challenges relates to the representation and modeling of the complexity of the systems, to the quantification of the system models and to the proper representation, propagation and quantification of the uncertainty in the system failure behavior and model. The focus on the research for techniques and methods to address such problems and challenges is strongly biased towards the new computational developments continuously stimulated by the constantly increasing computing power and capabilities. Reliability is a fundamental attribute for the safe operation of any modern technological system. Focusing on safety, reliability analysis aims at the quantification of the probability of failure of the system and its protective barriers. In practice, diverse types of protection barriers are placed as safe guards from the hazard posed by the system operation, within a multiple-barrier concept. These barriers are intended to protect the system from failures of any of its components, hardware, software, human and organizational. The seal need to be addressed by the system reliability analysis in a comprehensive and integrated manner. A fundamental issue in reliability analysis is the uncertainty in the failure occurrences and consequences.

In order to provide a seamless and reliable service in the most efficient manner, the maritime transportation system must deliver safe, secure, efficient and reliable transport of goods across the world, while minimizing pollution, maximizing energy efficiency and ensuring resource conservation. To achieve this, the complexity of the interrelation among actors in the maritime transportation system should be recognized and taken into account when addressing specific actions. The key elements of a sustainable maritime transport system are highlighted below.

A sustainable maritime transportation system requires well-organized administrations that co-operate internationally and promote compliance with global standards, supported by institutions with relevant



technical expertise, such as classification societies acting as recognized organizations (i.e. organizations entrusted by a flag State to carry out mandatory inspections and surveys on its behalf). In order to operate with the required high efficiency, a sustainable maritime transportation system requires coordinated support from the shore-side entities intrinsic to shipping, such as providers of aids to navigation, oceanographic, hydrographic and meteorological services, search and rescue services, incident and emergency responders, port facilities, trade facilitation measures, and cargo-handling and logistics systems.

As necessary as a reliable supply of fuel is for ships, so is a qualified and flexible work force a prerequisite for a sustainable maritime transportation system. An important challenge facing the shipping industry today is how to attract and retain a sufficient number of adequately trained and qualified seafarers and maritime industry professionals with the right motivation, knowledge and skills for the professional application of evolving technologies and procedures. This challenge will increase as world trade continues to grow and shipping activities increase accordingly. A sustainable maritime transportation system will need the collaboration of shore-side actors, from both industry and Governments, (in, for example, the due implementation of the Maritime Labour Convention), for the protection and provision of care for seafarers, in order to ensure that the system's social integrity does not become eroded and that qualified, professional seafarers have an attractive work environment.

**Management of safety and environmental protection.** The maritime transport company is to define their objectives for the key processes, functions and activities of safety and environmental protection, including but not limited to: provide/improve a safe working environment; provide/improve safe practices in ship operation; establish/improve safeguards against all identified risks; continuously improve safety and environmental protection management skills of personnel ashore and on board, including preparing for emergencies related both to safety and environment protection.

The maritime transport company is to develop, implement and maintain a corporate policy. The policy is to state the objectives and set out the means for achieving them. The policy is to ensure commitment to the following functional requirements: safety of personnel; safety of ship and property; environmental protection; prevention of process loss; compliance with rules and regulations

The company shall ensure that the Safety and Environmental Protection Management System operating onboard contains a clear statement of the Master's authority. The company shall establish in the Safety and Environmental Protection Management System that the Master has the overriding authority and the responsibility to make decisions with respect to safety and pollution prevention and to request the company's assistance as may be necessary.

The responsibility, authority and interrelationships of all personnel ashore and onboard who manage, perform and verify work affecting the Safety and Environmental Protection Management System shall be defined and documented. The responsibility to communicate this information and to verify that position/function descriptions are correctly understood is to be established and documented. Relevant information regarding the responsibility and authority of shore-based personnel supervising or supporting ship operations is to be included in the shipboard documentation.

The maritime transport company safety and environmental protection management system shall be documented in a well-structured format. This documentation is to be maintained and kept at the company's head office and all other relevant locations. All relevant elements of the safety and environmental protection management system shall be available onboard the ships.

**Security measures for ship and port facilities.** Maritime security can only be achieved by cooperative efforts among all the parties involved in the maritime industries, with primary emphasis on ships, port facilities and governments.

The aim of port security measures is to maintain an acceptable level of risk at all security levels. Security measures should be devised to reduce risks and should in the main revolve around procedures to establish and control access to restricted areas and other vulnerable or sensitive key points, locations, functions or operations in the port.

The port security assessment should be carried out by persons with the appropriate skills and should include the following: identification and evaluation of critical assets and infrastructure that it is important to protect; identification of threats to assets and infrastructure in order to establish and prioritize security measures; identification, selection and prioritization of measures and procedural changes and their level of acceptance in reducing vulnerability; identification of weaknesses, including human factors, in the infrastructure, policies and procedures; identification of perimeter protection, access control and personnel clearance requirements for access to restricted areas of the port; identification of the port perimeter and, where appropriate, the identification of measures to control access to the port at various security levels; identification of the nature of the expected traffic into or out of the port.

Today, related to ship security, it is clear that piracy is a serious threat to shipping across large parts of the Indian Ocean and Arabian Sea, as pirate groups grow in strength, resources and expertise. It has become apparent that a number of pirate groups are using captured vessels to act as mother-ships to increase their operational range, and of particular concern it appears that pirates are becoming increasingly aggressive in their use of weapons, and willing to make threats to harm the crew of hijacked vessels.

When considering the suitability of security measures for a vessel travelling through an area at risk of piracy, it is important to carry out a thorough risk assessment. There is no "one size fits all" policy of the appropriate security measures for a vessel, given that the risk assessment should be tailored according to the specifications of the ship, and should be voyage specific, taking into account the latest information on pirate activity on the proposed route. It is suggested a number of Ship Protection Measures which should be considered, including razor wire, water spray and ballistic protection for crew located on the bridge. Each of these suggestions should be considered on a case-by-case basis following the risk assessment.

It is clear that effective use of ship protection measures, including the use of citadels, has contributed to the reduced success rate of pirate attacks.

**Recognition and detection of dangerous substances and devices during ship operation.** Ships are vulnerable to explosive or incendiary devices: in accompanied passenger cars, freight vehicles or coaches; in unaccompanied vehicles, export cars or semi-trailers; in misdeclared cargo; carried on board by current passengers, or by those from a previous sailing leaving a timed device; in luggage placed in a baggage trolley; in ship's stores; in the post; carried on board by shore workers in port; carried on board by contractors' personnel.

Travelling as a foot passenger, the saboteur has to contend with customs and immigration authorities, and with being challenged by ship's staff if he attempts to disembark prior to sailing. There is also the possibility that a determined terrorist may plant a device and remain on board.

In addition to bomb threats, the potential use of radiological, biological and chemical weapons against ships and the people on them, although unlikely, should also be considered.

A ship's security plan should incorporate a search procedure aimed at ensuring that the vessel can be searched quickly and effectively when this is considered necessary. Search plans should be prepared in advance, to help ensure the maximum effectiveness of the search. They should be practised from time to time to build up confidence on the part of the crew and remind them that good security is everyone's business. In areas or periods of high risk or if information on specific threat has been received, searches might be made after leaving each port. Compartments which are tidily stowed are more easily, quickly and effectively searched. In the interests of good security, as well as good ship husbandry, as much gear as possible should be stowed away.

In addition to a comprehensive search plan a plan for a fast search or 'quick look' of the more vulnerable and accessible areas should be drawn up. Using the card system, selected cards only would be issued to cover the vulnerable and accessible areas. It must, however, be emphasized that all bomb threats must be treated as real unless judged or proven otherwise. Searchers should be instructed to bear in mind that the terrorist may try to match the device to the background such as a tool box in an engine room. At higher levels of threat, searches of people and goods may need to be carried out. Such a fast search might be carried out where: there is a short warning time before a potential bomb detonation; security management judges that a received bomb threat needs checking out; and, an opportunity occurs to conduct a quick search.

There are two types of search:

*Reactive Search* - this type of search is normally carried out in reaction to a specific threat or piece of hard intelligence indicating that bomb or weapons have been placed. It can also be used as a precaution during times of heightened threat; and,

*Preventive Search* – this aims to deter terrorists from smuggling bombs or arms onboard a ship or into a terminal or restricted area, and to find these devices if the terrorist tries to smuggle them in.

Very important: *The discovery of one device should not be the end of a search as there is always the possibility that more than one has been planted.*

**Methods for prevention of security threats in maritime operations.** Complexity and ambiguity are hallmarks of today's security environment, especially in the maritime domain. In addition to the potential for major combat operations at sea, terrorism has significantly increased the nature of the non-military, transnational, and asymmetric threats in the maritime domain that all states and involved organizations must be prepared to counter. Unlike traditional military scenarios in which adversaries and theaters of action are clearly defined, these non-military, transnational threats often demand more than purely military undertakings to be defeated.

In the present, threats to maritime security are classified as:

*Nation-State Threats* - the prospect of major regional conflicts erupting, escalating and drawing in major powers should not be discounted.

*Terrorist threats* - non-state terrorist groups that exploit open borders challenge the sovereignty of nations and have an increasingly damaging effect on international affairs.

*Transnational criminal and piracy threats* - the continued growth in legitimate international commerce in the maritime domain has been accompanied by growth in the use of the maritime domain for criminal purposes.

*Environmental destruction* - intentional acts that result in environmental disasters can have far reaching, negative effects on the economic viability and political stability of a region.

*Illegal seaborne immigration* - international migration is a long-standing issue that will remain a major challenge to regional stability, and it will be one of the most important factors affecting maritime security through the next years.

**Role of human factor in maritime operation safety management.** The issue of marine safety should be regarded as the key priority concerning the planning and practice of maritime transport procedures, in a worldwide scale. Since the vast majority of world trade is being conducted through sea-borne ways, maritime safety should be viewed as a factor that needs extreme caution, detailed planning, self-commitment and obligatory enforcement.

There are several causes that can rupture the aforementioned transport chain, with undesired consequences. This can be resulted from unsolved mechanical or electrical problems, hazardous external conditions (such as severe weather), poor human factor behavior or performance (e.g. inadequate bridge resource management), accidental events (like an unpredictable hull problem) etc. However, it is a fact that human element is the basic and by far the most frequent reason that leads towards marine accidents. Each involved player (e.g. crew, shore management, classification societies etc) has been recorded as the responsible component for numerous verified mishaps, which could have been averted under different circumstances. Thus, the correct way to respond to casualties and exploit its knowledge potential is to analyze the “mistakes” (mainly human errors) that caused them and assay to prevent them from appearing ever again.

The value of human factors considerations in the analysis of system safety is obvious and often stated: humans are associated with the procurement, design, operation, management, maintenance and disposal of all systems in some form, and therefore the associated successes and failures of those systems. In addition, most theoretical models of accident causation recognise the centrality of humans to system safety, both as unwitting contributors to safety incidents, and as important barriers and sources of recovery from hazards.

Given this background, there is a long tradition of the consideration of ‘human factors’ in system safety, and in avoiding the ‘potentially harm-producing’ system states such as incidents and accidents. There are a number of reasons why it is necessary and valuable to look at Safety Management System from a Human Factors perspective.

The discipline of Human Factors stresses the importance of capturing and understanding the reality of operations. It is these activities, as they are performed in the operational context, which can have the influence on safety. The structural and operational aspects of the Safety Management System are linked and interdependent.

To summarise, from a human factors perspective a safety management can be seen as a socio-technical system that relies on the performance of people (the ‘operational’ aspect) and the sufficiency of the processes and procedures (the ‘structural’ aspect) in order to successfully function.

Given this viewpoint, it follows that there will be human factors challenges and barriers for those implementing the safety management system.

**Occupational health and safety in maritime environment.** The resources necessary to safeguard the safety and health of all persons affected by ship or port operations should be managed so that a balance is achieved between the risks of operations and the cost of eliminating or reducing accidents. The real costs of injuries and ill health and the risks from the hazards of operations should therefore be assessed.

The true financial costs of accidents and illness should include the cost of direct damage, lost time and personal injury claims, as well as consequential costs such as time spent in administration, defending any claims that might be made, and replacing personnel. The costs of accidents that do not result in injury should not be overlooked; they can provide an effective warning of potentially more serious incidents in future, thus saving considerable sums.

The outcome of an event may range from no injury to fatal injury and major damage, with only the smallest change to one factor. A “total loss” approach to accident prevention recognizes this fact and includes investigation of non-injury incidents. Organizations need to learn from all such incidents in order to achieve effective control.

National and local safety and health management systems for ships and ports should be based on risk assessment, in accordance with the main elements of the ILO’s *Guidelines on occupational safety and health management systems*.

Accidents are unplanned events. Working in a structured manner that recognizes and controls potential hazards can minimize such events. This is the basis of a safe system of work. Such systems result in safer and more efficient operations. Although they may not have been developed with safety in mind, quality control systems similarly result in safer operations by ensuring that operations follow specified patterns, thereby minimizing unplanned events.

To be effective, a safe system of work should be developed in consultation with all parties involved with putting it into practice. Once finalized, it should be promulgated by appropriate means and any necessary training carried out before it is put into effect. Supervisory staff should monitor the implementation and effectiveness of the system in practice and be alert for any problems that may occur. Safe systems of work should be reviewed periodically in the light of changes and operational experience, and revised as necessary.

**Damage control concerning personnel.** Damage control aboard ship involves any prudent action that will; prevent or reduce expected damage to the ship, stabilize the situation caused by the damage, reduce or negate the effects of damage to the ship after it has occurred. The main purpose of damage control is to keep the ship afloat and to return to port for reparation with the minimal loss of property or life. The necessity for the practice of damage control aboard ship is not limited to just plugging and patching holes in the hull plating; an accident aboard ship demands an aggressive systematic response by the professional mariners aboard.

Mariners must be knowledgeable about all aspect of the ship on which they work and not just with their berthing space, mess deck, workstation, and the location of the disbursing office. When the emergency signal is sounded aboard, all crewmembers will be called upon to perform in areas outside their normal workstation. This will be determined by which zone aboard the perceived damage has initially occurred and the location and the extent of the actual damage, and if the damage is spreading to other parts of the ship.

In the same time, Organization is the key to successful damage control. The damage control organization establishes standard procedures for handling various types of damage. It sets up training for these procedures so that every person will know immediately what to do in each emergency situation.

Damage control has various vital objectives, both preventive and corrective. All personnel must adhere to these objectives. Some of these actions are as follows: maintain the established material conditions of readiness; train all personnel in all aspects of shipboard damage control; and, maintain damage control systems and equipment in the best condition possible to ensure survivability

Having successfully completed the course, the student will be able to:

- ✓ *Understand the basic attributes and behavioural characteristics of complex transport systems*
- ✓ *Explain the history of safety development in maritime transport in reactive and proactive safety improvement approaches*
- ✓ *Organize and apply principles, concepts and terms of risk assessment and safety management within the maritime transport concept*

- ✓ *Identify the different entities active within maritime transport system and with impact on ship operation*
- ✓ *Identify on board emergency during ship operation in port*
- ✓ *Explain emergency preparedness and management, and the role of analytical approaches for improvement of these*
- ✓ *Classify human factors issues as part of safety assessment in maritime transport, and perform quantitative human reliability analyses*
- ✓ *Apply the international regulations related to safety of maritime transport operations*
- ✓ *Apply an efficient management of ship operations and prediction of threats.*

### **3.2 Course no.2: Navigation safety**

This course has 120 hours with 7 ECTS and aims to prepare the trainees for sailing at sea and is designed to provide prospective mariners with an in-depth knowledge of the practical requirements for safety of navigation. In the course are analyzed all condition of sailing, kinds of navigation threat to the vessel during sailing, meaning and intend of Collision Regulations as they apply to the behavior of the vessel in risk of collision. Each topic is introduced in lecture supported by electronic presentation, followed by examples, case studies and discussion.

Through this course is expected that those who successfully complete this course will claim knowledge about:

- ✓ Plotting of ships position and piloting;
- ✓ Evaluation of the accuracy of ship's position;
- ✓ Collision regulations and actions to avoid collision at sea;
- ✓ Aids to navigation;
- ✓ Safety of navigation according to SOLAS ch.5 requirements;
- ✓ Bridge organization and bridge watchkeeping;
- ✓ Bridge resources, team and work operations;
- ✓ Requirements for passage plan preparation;
- ✓ Monitoring the passage plan by all means of navigation;
- ✓ Sailing of ships in pilotage waters and harbors;
- ✓ Sailing of the vessel in coastal waters;
- ✓ Ice navigation;
- ✓ Sailing in confined and restricted waters;
- ✓ Anchorage the vessels and staying at anchor;
- ✓ Using of weather routing;
- ✓ Organization of watch in a port.

The achievement of the knowledge and competences described above will be realized passing course chapters as presented in summary below.

**Contemporary problems of navigation safety.** IMO has always paid great attention to the improvement of navigational safety. Since 1959 a whole series of measures have been introduced, in the form of conventions, recommendations and other instruments. The best known and most important of these measures are conventions, three of which are particularly relevant to navigation. These are the International Convention for the Safety of Life at Sea, 1974 (SOLAS); the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREG); and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW).

Safe shipping depends on the ability to plan a safe voyage and in this respect free passage and the right to innocent passage at sea are crucial. BIMCO fully recognises that thoroughly planned routing systems that have been approved by the IMO contribute to safety of life at sea, protection of the environment and efficiency of navigation. Shipping has however a strong tradition for free navigation at sea, which makes it possible for the shipping industry to supply the customers with flexible solutions and to adapt to weather and prevailing conditions at sea. This operational freedom should be kept to the maximum extent possible and it should be noted that routeing systems should be recommended for use and thus not mandatory. Furthermore, efficient shipping depends on the possibility to choose the most energy efficient routes thus reducing emissions from ships.

**Navigation safety implemented in SOLAS Chapter V and ISM Code.** Of all the international conventions dealing with maritime safety, the most important is the International Convention for the Safety of Life at Sea (SOLAS), which covers a wide range of measures designed to improve the safety of shipping. Chapter V identifies certain navigation safety services which should be provided by Contracting Governments and sets forth provisions of an operational nature applicable in general to all ships on all voyages. This is in contrast to the Convention as a whole, which only applies to certain classes of ship engaged on international voyages.

Much has been written of the need for nations to maintain uniform rules governing the legal relationships of those engaged in maritime commerce. Though the intended benefit of such uniformity is promotion of international trade, of greater importance is the need for uniform international standards to protect life and property. The desire to achieve uniform safety and environmental standards is especially pronounced in the maritime industry. A maze of differing and often conflicting laws would exist if each nation developed its own safety legislation. For example, some nations might insist on very high safety standards while others might be more lax, acting as havens for sub-standard shipping.

At its 16th session held in October, 1989, the Assembly adopted Resolution A.647 (16) containing the first IMO "Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention." Although the 1987 resolution had applied only to passenger ferries, resolution A.647 (16) applied to all ships. The IMO's Secretary-General stated that this broader application was in "recognition of the importance of sound management to shipping safety in general."

The objectives of the Code are to ensure safety at sea, prevent human injury and avoid damage to the environment and to property. The Code does not create specific operating rules and regulations, but provides a broad framework for vessel owners and operators to ensure compliance with existing regulations and codes, to improve safety practices and to establish safeguards against all identifiable risks. It also sets forth the safety management objectives, which "should" be adopted by companies.

The fundamental condition of a good safety management is the highest commitment. In the issues of safety and pollution prevention the final result is determined by the commitment, competence, attitude and motivation of individuals at all levels.

Implementation of such a system is a condition to maintain each ship in the international traffic circuit.

**Sailing in confined waters.** The Coastal Phase is considered to exist when the distance from shore makes it feasible to navigate by means of visual observations, radar and if appropriate, by depth (echo) sounder. As with the Ocean Phase the distances from land can be varied to take account of the smaller vessels and local geographical characteristics.

Before passing hazardous waters, the prudent navigator should develop a feasible plan for deriving maximum benefit from available navigational means. In developing his plan, the navigator should

study the capabilities and limitations of each means according to the navigational situation. He should determine how one means, such as cross-bearing fixing, can best be supported by another means, such as fixing by radar-range measurements.

The navigator must be prepared for the unexpected, including the possibility that at some point during the transit it may be necessary to direct the movements of the vessel primarily by means of radar observations because of a sudden obscurity of charted features. Without adequate planning for the use of radar as the primary means for insuring the safety of the vessel, considerable difficulty and delay may be incurred before the navigator is able to obtain reliable fixes by means of radar following a sudden loss of visibility.

An intended track which may be ideal for visual observations may impose severe limitations on radar observations. In some cases a modification of this intended track can afford increased capability for reliable radar observations without unduly degrading the reliability of the visual observations or increasing the length of the transit by a significant amount. In that the navigator of a radar-equipped vessel always must be prepared to use radar as the primary means of navigating his vessel while in pilot waters, the navigator should effect a reasonable compromise between the requirements for visual and radar fixing while determining the intended track for the transit.

A Restricted Waters Phase can develop during a coastal navigation phase, such as in various Straits, channels and inland waterways around the world.

The Pilot or Master of a large vessel in restricted waters must direct its movement with great accuracy and precision to avoid grounding in shallow water, striking submerged dangers or colliding with other craft in a congested channel. If a large vessel finds itself in an emerging navigational situation with no options to turn away or stop, it may be forced to navigate to limits measured within a few metres in order to avoid an accident.

Requirements for safety of navigation in the Restricted Waters Phase make it desirable for navigation systems to provide: accurate verification of position almost continuously; information depicting any tendency for the vessel to deviate from its intended track; and, instantaneous indication of the direction in which the ship should be steered to maintain the intended course.

These requirements are not currently achievable through the use of visual aids and ships' radar alone, but as with Harbour Approach navigation, they can be achieved with a combination of DGPS and electronic charts systems.

**Sailing in restricted visibility.** Among the critical conditions for navigation are those in restricted visibility. When sailing at night, during limited visibility, or in an area where the visibility may decrease while, there are a number of special considerations that must be addressed to maintain a reasonable margin of safety. Vessel operators should be familiar with, or well informed of, the operational area in clear conditions and daylight. They must also be aware of any hazards to navigation and possible rapid environmental changes. The navigator must also be familiar with sound signals and lighting schemes of vessels, aids to navigation, and local shore-based features.

The common among all this cases is that the navigator due to the restricted visibility the visual observation is reduced and can rely mainly on navigational aids. When encountering restricted visibility "every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. A power-driven vessel shall have her engines ready for immediate maneuver." (Navigation Rules #19). A general rule of thumb could be to operate a vessel at a speed no faster than it can be brought to a stop in one half the distance you can see.

Crew members should always act as lookouts when underway. During a briefing before operations at night or in restricted visibility provides an opportunity to formally review the lookout's role and duties.



The bad weather conditions make difficult the detection of targets by radar - reducing the distance of detection and differentiating of the target in an area of intense rain and low clouds becomes impossible. In this aspect, the reduction of disturbance during operation of the radar is one of the main tasks of the navigators to increase the efficiency of monitoring. After relieving the watch the watch officer is obliged to check the settings of the radar to determine the optimal parameters for operation.

Priority of navigation safety at open sea is defining of the exact position of ship-targets and their course and speed. Determining the position of the ship does not pose a problem in the modern world. The use of GPS, ECDIS, IBS, and ARPA facilitates the work of navigators significantly therefore he has more time to observe and analyze the situation.

**Ice navigation.** Sea ice has posed a problem to the navigator since antiquity. Ice is of direct concern to the navigator because it restricts and sometimes controls his movements; it affects his dead reckoning by forcing frequent changes of course and speed; it affects piloting by altering the appearance or obliterating the features of landmarks; it hinders the establishment and maintenance of aids to navigation; it affects the use of electronic equipment by affecting propagation of radio waves; it produces changes in surface features and in radar returns from these features; it affects celestial navigation by altering the refraction and obscuring the horizon and celestial bodies either directly or by the weather it influences, and it affects charts by introducing several plotting problems.

The propulsion plant and steering gear of any ship intending to operate in ice must be reliable and must be capable of a fast response to manoeuvring orders. The navigational and communications equipment must be equally reliable and particular attention should be paid to maintaining radar at peak performance.

The independent navigation in ice areas is a serious challenge for the crew and ship's engine, propulsion system and mechanisms. In the view of this all publications recommend if it is possible to be avoided or to be chosen the safest and shortest route. At the entry of the vessel into a zone of floating ice is necessary the ice edge to be timely determined (especially in case of restricted visibility). When approaching a dangerous area the vessel must reduce the speed and the crew must to be ready for timely actions.

Vessels unsure of their ability to cope with prevailing ice conditions on their own may require icebreaker or escort assistance. Icebreakers are available for escort and support of shipping, towing operations, ice reconnaissance, and rescue operations. Navigation in ice areas is regulated by the local rules of the shore authority and they are obligatory for navigators. These rules define the reporting procedure to request an icebreaker, the way of communication with the icebreaker, guidelines for the icebreaking escort operation.

SOLAS and MARPOL, the IMO *Guidelines for Ships Operating in Polar Waters* (Polar Guidelines) aim to promote safety of navigation and to prevent pollution from ship operations in polar waters. The Polar Guidelines take into account that the single most significant factor in polar operations is ice by recommending that only those ships with a Polar Class designation or a comparable alternative standard of ice-strengthening appropriate to the anticipated ice conditions should operate in polar ice-covered waters. The Polar Guidelines stipulate that systems should provide adequate levels of safety in emergencies. In addition, The Polar Guidelines recognize that safe operation in polar conditions requires specific attention to human factors including training and operational procedures. Guidance regarding training of masters and officers for ships operating in polar waters is contained in the *Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) Code, Section B-V/g\*. Work to further develop internationally recognized criteria for training and experience for ice navigators is underway at IMO as part of the development of a proposal for a mandatory Polar Code.

**Sailing at seas with hurricane activities.** A tropical cyclone is a cyclone originating in the tropics or subtropics. Although it generally resembles the extra tropical cyclone of higher latitudes there are important differences, the principal one being the concentration of a large amount of energy into a relatively small area. Tropical cyclones are infrequent in comparison with middle and high latitude storms, but they have a record of destruction far exceeding that of any other type of storm. Because of their fury, and because they are predominantly oceanic, they merit special attention by mariners.

The modern equipment of ships ensures gathering information about tropical cyclones from different sources – a text information from “INMARSAT”, a weather forecast from “NAVTEX”, radiofacsimile weather maps, a radio weather forecast and the own ship weather observations. These broadcasts, covering all tropical areas, provide information about the tropical cyclone’s location, maximum winds and seas, and future conditions expected. The tropical warning services have three principal functions: collection and analysis of data; preparation of timely and accurate warnings; and, the distribution of advisories.

From navigation point of view, the safest procedure with respect to tropical cyclones is to avoid them. If action is taken sufficiently early, this is simply a matter of setting a course that will take the vessel well to one side of the probable track of the storm, and then continuing to plot the positions of the storm center as given in the weather bulletins, revising the course as needed. However, this is not always possible. If the ship is found to be within the storm area, the proper action to take depends in part upon its position relative to the storm center and its direction of travel. It is customary to divide the circular area of the storm into two parts. In the Northern Hemisphere, that part to the right of the storm track (facing in the direction toward which the storm is moving) is called the dangerous semicircle. It is considered dangerous because (1) the actual wind speed is greater than that due to the pressure gradient alone, since it is augmented by the forward motion of the storm, and (2) the direction of the wind and sea is such as to carry a vessel into the path of the storm (in the forward part of the semicircle).

**Watchkeeping.** The Navigational watch is responsible for the safe navigation of the ship from the port of departure to the last port of call. The appropriate management of the navigational watch is in compliance with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). The provisions of STCW strongly address the human element of bridge team management. They mandate maximum duty hours, minimum rest periods, and training requirements for specific navigational and communications systems such as ARPA and GMDSS. They require that officers understand and comply with the principles of bridge resource management. They require not merely that people be trained in certain procedures and operations, but that they demonstrate competence therein. Competence may be demonstrated at sea or in approved simulators, and must be documented by Designated Examiners (DE’s) who provide documentation which will allow the examinee to be certified under the provisions of STCW.

The basic principles for navigational watchkeeping are defined also by IMO in Resolution A.285 (VIII) according to the responsibility of the officer on watch to maintain an effective look-out.

Organization of an appropriate look-out is one of the most important elements of the navigational watch in case of navigation in complicated conditions.

The information on bridge must be transmitted in a certain strictly defined by the master order. He decides when and by whom to require information. It is usual with him to communicate the officer on watch and the additional navigation officer.

Watch officers should not relieve the watch in the middle of an evolution or when casualty procedures are being carried out. This ensures that there is watchstander continuity when carrying out a specific

evolution or combating a casualty. Alternatively, the on-coming watch officer might relieve only the conn, leaving the deck watch with the off-going officer until the situation is resolved.

The officer in charge of the navigational watch shall not hand over the watch to the relieving officer if there is reason to believe that the latter is not capable of carrying out the watchkeeping duties effectively, in which case the master shall be notified.

**Anchoring the vessel.** The navigation safety of anchoring concerns two stages: to select the anchoring position and anchoring operation. The anchorage must provide sufficient depth under the keel for all stages of the tide and anticipated vessel trim. Sufficient clearance must be available for the ship to pass over its own anchors safely. If significant tidal currents will be experienced, an allowance for the squat of the ship at maximum current must be included. The anchorage must provide sufficient room for the ship to swing clear of all shoals, obstructions and other vessels. Anchors should be equipped with a marker buoy, especially where there is a record of anchors being lost.

All advice received from local authorities should be viewed with suspicion, the master being guided primarily by the actual conditions observed, indications of the admiralty/coast pilot, the sailing directions and navigation chart information. If the observed water depths are less than those indicated by local pilots, receivers, or facility operators, then the master has the right and obligation to abort the mooring operation and request that supplementary soundings be made to verify the adequate safe depth.

The master and officers of the watch must regularly fix the position of the ship while approaching the anchorage and verify that the ship is making the agreed courses to the anchorage. The speed over the ground and depth of water under the keel should be frequently verified and the depth alarm used, (if fitted). The chief officer normally handles the anchor, ensuring well beforehand that all the anchoring equipment is available and the windlass is in all respects ready for use. Preparations must always be supervised by a deck officer and only experienced crew members should handle the anchor machinery. An anchor watch must be set with clear instructions to *use all available means* to verify that the vessel is not dragging its anchor. Enter anchor bearings in the log and plot the anchored position on the chart. Plot a 'bridge turning circle' using the scope of chain and the ship's length. Use cross bearings to regularly verify that the bridge is remaining within the circle drawn on the chart.

Engines should be maintained ready for manoeuvring if necessary and the watch officer clearly instructed that he is required to use the engines if necessary to avoid danger to the vessel. The anchor watch must keep a vigilant, all around lookout. Approaching vessels should be tracked by radar and visual bearings as if own vessel were under way.

**Introduction and basic description of bridge team and resources management.** Like all knowledge-based skills, bridge watchkeeping and navigation require practice, support and reaffirmation. Left unattended they can become casual. The actions taken on the bridge may be uncritical and the interchange of information between the Master and the watchkeeping officers lapses into a working relationship where assumptions are made without being verified.

Tasks of the bridge team and resources management are to explain how to prepare the bridge for safe well-planned navigation, which is directed by the Master, officers and crew in such a way that the ship is always conducted under positive control, supported by the pilot when one is taken. It is true that modern electronic systems can be used to automate bridge tasks and thereby alter the balance of duties performed on the bridge.

The ability of the personnel onboard to coordinate their activities and to efficiently communicate between them is vital in emergency cases. Especially for the leader (Master) it is important to be able

to communicate efficiently with the members of the bridge team whenever it is necessary but in most of the cases it is important for the Master to be able to transmit his intentions and orders to his crew members, especially in cases of emergency.

If the Master is making a good schedule of the ship's voyage, the bridge team will have a better control of the ship's evolution and will avoid the appearance of unpredicted events due to the configuration of the navigation area.

It must be clear stated in the company's safety management system the Master's duties regarding taking decisions about ship's safety and their responsibilities, but also regarding the possibility of taking over the officer's duties when this is necessary.

The Master must not be forced by the company in any way in taking decisions regarding ship's safety and safety of navigation, especially in rough weather and rough seas conditions.

**Team management.** A team is a group of people coming together to collaborate. This collaboration is to reach a shared goal or task for which they hold themselves mutually accountable. A team outperforms a group and outperforms all reasonable expectations given to its individual members. That is, a team has a synergistic effect - one plus one equals a lot more than two. Team members not only cooperate in all aspects of their tasks and goals, they share in what are traditionally thought of as appraisal and planning of the passage, organizing watches and drills, developing their own strategies to manage change etc.

Leadership is a complex process by which a person influences others to accomplish a mission, task, or objective and directs the organization in a way that makes it more cohesive and coherent. A person carries out this process by applying leadership attributes – belief, values, ethics, character, knowledge, and skills. The best leaders are continually working and studying to improve their leadership skills. Leadership makes people *want* to achieve high goals and objectives, while, on the other hand, bosses tell people to accomplish a task or objective.

Management Leadership involves the ability to effectively manage and/or participate in a Bridge Team. This requires: technical knowledge about the ship; Leadership or people skills; and, proactive approach.

**Stress and risk management.** Stress is a fact of life, wherever we are and whatever we are doing. We cannot avoid stress, but we can learn to manage it so it doesn't manage us. Stress is the way human beings react both physically and mentally to changes, events, and situations in their lives. People experience stress in different ways and for different reasons. The reaction is based on human's perception of an event or situation. If a person view a situation negatively, he will likely feel *distressed*—overwhelmed, oppressed, or out of control. Distress is the more familiar form of stress. The other form, *eustress*, results from a "positive" view of an event or situation, which is why it is also called "good stress."

Seafaring is a working activity with particular characteristics and is performed in specific contexts from a physical and psychosocial point of view. Work-related stress affecting seafarers has particular characteristics often different from stress that can be appreciated in other working activities. These include many possible dangers in the form of accidents, injuries, and diseases. Seafaring risks depend on the type of activity or work on board. This activity must be regarded as strenuous due to the multitude of factors within and without the ship that come to bear on it.

Work of seafaring is characterized by subjective and objective stress factors. Subjective factors rely on the self-assessment of the person's own condition and on the degree of personal satisfaction that work produces.

Subjective factors playing a role in the cause of accidents on board are very difficult to assess. They are probably the cause of more than 50% of accidents and the most frequent reasons for absence from work at sea.

**Error chain.** Maritime incidents or disasters are very seldom the result of a single event, they are almost invariably the result of a series of non-serious incidents; the culmination of an error chain. Situational awareness—i.e., knowing what is going on around the ship—helps the OOW to recognize that an error chain is developing and taking such action, based upon this awareness, to break the error chain. Certain signs in the function of a bridge team will indicate that an error chain is developing. This does not mean that an incident is about to happen; it does mean that the passage is not being carried out as planned and that certain elements of situational awareness may be lacking. The ship is being put at unnecessary risk and action must be taken to break the error chain.

**Teamwork.** IMO Resolution 285 requires that the OOW *'ensures that an efficient lookout is maintained'* but concedes that *'there may be circumstances in which the officer of the watch can safely be the sole lookout in daylight.'* However: *'When the officer of the watch is acting as the sole lookout he must not hesitate to summon assistance to the bridge, and when for any reason he is unable to give his undivided attention to the lookout such assistance must be immediately available.'* (Annex B 2.) It is normal practice to have the uncertificated watchkeeper working in the vicinity of the bridge where he can be called should he be required. At night the lookout is normally on the bridge carrying out his exclusive lookout duties.

Success or failure in running the ships is a result of whether Masters and officers work together effectively in teams. Some shipowners and ship operators have a very good record in teamwork. Therefore managers on shore should regularly look at how they are managing their teams and constantly compare their performance against the best practice in the world. Only by doing this certain shipowner can keep one step ahead of the competition.

**Passage plan.** IMO requirements regarding passage planning are well described in SOLAS Chapter V. According to the convention every vessel shall depart the port with well-planned and prepared in advance passage plan for forthcoming voyage.

Before any voyage can be embarked upon or, indeed, any project undertaken, those controlling the venture need to have a good idea of the risks involved. The appraisal stage of passage planning examines these risks. If alternatives are available, these risks are evaluated and a compromise solution is reached whereby the level of risk is balanced against commercial expediency. The appraisal could be considered to be the most important part of passage planning as it is at this stage that all pertinent information is gathered and the firm foundation for the plan is built.

On the basis of the fullest possible appraisal, a detailed voyage or passage plan must be prepared, covering the entire voyage or passage from berth to berth, including those areas where the services of a pilot will be used.

Having finalized the voyage or passage plan, as soon as time of departure and estimated time of arrival can be determined with reasonable accuracy, the voyage or passage should be executed in accordance with the plan or any changes made thereto.

The plan should be available at all times on the bridge to allow officers of the navigational watch immediate access and reference to the details of the plan.

The progress of the vessel in accordance with the voyage and passage plan should be closely and continuously monitored. Any changes made to the plan should be made consistent with prevailing guidelines. All changes must be clearly marked and recorded.

**Sailing with Pilot on board.** A pilot is a mariner who guides ships through dangerous or congested waters, such as harbors or river mouths. Pilots are expert shiphandlers who possess detailed knowledge of local waterways. The master has full responsibility for safe navigation of his vessel, even if a pilot is on board. If he has clear grounds that the pilot may jeopardise the safety of navigation, he can relieve him from his duties and ask for another pilot or, if not compulsory to have a pilot on board, navigate the vessel without one.

Pilotage is one of the oldest professions, as old as sea travel itself, and it is one of the most important in maritime safety. The oldest recorded history dates back to about the 7th century BC. The economic and environmental risk from today's large cargo ships makes the role of the pilot essential.

**Operational use of ECDIS for navigation safety.** An officer who is in charge of a navigational watch on board a ship of 500 GRT or more should have attained the minimum standard of competence specified in Table AII/1 of STCW Code. The competence includes “Plan and conduct a passage and determine position” of the vessel, in which he should have thorough knowledge of and ability to use navigational *charts* and publications, NTM, radio navigational warnings and ships’ routeing information. Note: ECDIS systems are considered to be included under the term “charts”.

The ECDIS enables the user to call up information on the items displayed in addition to the graphics presentation.

**Errors in ECDIS Data interpretation and risk assessment.** Errors in displayed data, like: inaccuracy of hydrographic data, poor resolution, shifting of navigational marks position, reference position of sensors, radar data and ARPA information, different geodetic co-ordinate systems.

Correctness of displayed data: by comparing ECDIS and radar information, by checking the ship’s position by means of a second independent position-fixing system.

Verify the results of manual and/or automatic data correction: by comparing ECDIS and radar information by checking the ship’s position by means of a second independent position-fixing system.

False interpretation of data: ignoring overscale of the display, uncritical acceptance of own ship’s position, confusion of display mode, confusion of chart scale, confusion of reference systems, different modes of presentation, different modes of vector stabilisation, differences between true north and compass north.

**Characteristics of electronic navigation sensors in ECDIS.** As per IMO performance standards, an ECDIS should be connected to a ship’s position-fixing system, to a gyro compass and to a speed and distance measuring device. For any ships without a gyro compass, ECDIS should be connected to a marine transmitting heading device. However, most modern ECDIS already integrate the majority of navigational systems on modern bridges but are subject to the condition that their integration does not degrade the performance of any equipment providing sensor inputs or the performance of ECDIS itself. The benefits of integrating additional navigational systems will include providing the mariner with a greater perspective of the navigational picture whilst increasing situational awareness. The navigation officer’s work load decreases as information relating to the safe navigation of the ship (for example, depth, speed and course) can be readily viewed on the ECDIS display as well as other important information.

**Shiphandling – basic principles.** Each ship will have its own manoeuvring characteristics. The position of the pivot point will vary performance, while performance itself can be affected by numerous factors; not least, growth on the hull. The propellers, of such varied construction these days, can expect to generate increased thrust with reduced cavitation, while ‘slip’ and transverse thrust affects have as yet, not been eliminated from propeller activity.

It is now recommended that manoeuvring information in the form of a “Pilot Card”, “Bridge Poster” and “manoeuvring booklet” should be retained on board ships. Such information should include comprehensive details on the following factors affecting the details of the ship’s manoeuvrability, as obtained from construction plans, trials and calculated estimates.

**Pivot point.** Traditionally the pivot point of a ship has been defined as the centre of ship’s rotation. Thus the ship’s motion has become to the eyes of ship handlers a simple one of surge and yaw only. Due to this simplicity, the concept has been very useful in helping to analyze the manoeuvring of a ship, and thus the term is used extensively in teaching and training ship handlers their essential techniques. However, ship’s motion in a small confined area is at least a general planar motion involving surge, sway and yaw. Thus using the traditional definition, calculating the position of the pivot point was not possible, and taken roughly as located at a third (quarter) of ship length from the bow (stern) when moving ahead (astern). In recent decades ships have become bigger in size and forced to operate in relatively smaller port or harbor areas, which demands more precise and skilled manoeuvring from ship handlers. This in turn made it necessary to know more precisely the location of the pivot point.

**Ship manoeuvring characteristics.** Each ship will have its own manoeuvring characteristics. The position of the pivot point will vary performance, while performance itself can be affected by numerous factors; not least, growth on the hull. The propellers, of such varied construction these days, can expect to generate increased thrust with reduced cavitation, while “slip” and transverse thrust affects have as yet, not been eliminated from propeller activity. Interaction inside the marine environment is noticeable in several forms, where a ship can experience a reaction from a land mass or another ship; typically, a parent vessel reacting with the smaller tug – the weaker element with the stronger. Interaction can be observed as squat, a bank cushion affect, or just an unexpected movement between two vessels in close proximity. Whatever form interaction takes, it is generally seen as undesirable and unwanted. Mariners have become familiar with its effects over the years and the industry has gone some way to educate our seamen in anticipation of what to expect. Bearing this in mind, it would seem obvious to avoid the experience if possible, or if it is going to be encountered, then we should know how to counter its adverse effects.

**Operations with tugs in port.** There are a variety of tug types employed within the marine industry. They include the ocean-going salvage tug down to the smaller harbour traction tug, engaged in and around ports and harbours. Ship handling situations warrant tug use either in a pulling or a pushing mode in numerous situations. The large VLCC or ULCC tankers, for instance, would experience great difficulty in attaining and departing their berths safely, without the assistance of probably at least four tugs. Entering docks, turning into rivers and engaging in tight manoeuvres, tends to be that much easier and safer with tugs engaged. This is especially so with the large ocean-going vessels that may have limited manoeuvring aids and be restricted to a right hand fixed propeller only.

By the very nature of any environment where tugs are engaged, heavy duty operations are envisaged. Towing springs and similar weight bearing ropes are inherently dangerous to personnel who may have

to work in close proximity. Full safety aspects should be applied at all times throughout tug operations. Effective communications must be maintained between relevant parties and contingency plans should be in place to reduce the likelihood of accidents throughout this high risk activity.

**Ocean going towing operation.** Various circumstances may dictate the needs to conduct an Ocean (long distance) towing operation. The vessel intended for tow may be disabled, or she may be on route to be scrapped. Whatever the reason for the towing operation, certain requirements must be complied with to ensure the operation is carried out safely.

In any towing operation the essential element is the towline. Its selection in the first place should take account of strength. Its length and size will reflect the elasticity but will also influence the handling position of the vessel being towed. A short length of towline is easier to control and reduces “Yaw” on the vessel being towed, whereas a long length in the towline has greater shock absorption throughout its length.

Good leads must be provided for every towline and should favour less friction bearing surfaces where possible. Sharp angled leads should be avoided at all costs. Adequate lubricant should be applied regularly to the bearing surface of leads to reduce friction burns. The towline should also be able to be length adjusted, to ensure even wear and tear on a variable length of the towline.

The speed of operation should consider the tension in the towline and not be such as to cause the line to snatch. Regular checks on weather forecasts should allow the line to be adjusted in ample time, prior to entering heavy weather. In the event that the towline is parted, suitable means of recovery should be kept readily available throughout the period of tow.

**Ship to ship transfer operation.** In the context of this topic ship to ship transfer is the transferring of a cargo, more often oil, between vessels in the open sea and not in a port or harbour. The need for ship to ship transfer arises because some modern tankers are so large that they are unable to enter some ports. If a cargo of oil is intended for a port which the large ocean going tanker cannot enter, then the oil will need to be transferred to smaller tankers to take it into harbour. Similarly if the exporting port cannot accommodate deep hulled tankers then they may wish to export the oil from the port in small tankers, then transfer it to the larger vessel for the rest of its journey.

**Manoeuvring for anchorage.** The high holding power anchors, the use of multiple anchor moorings and the sheer size of anchors for the larger vessel, have all brought with them associated operations and relevant complications. Anchor cables are brought into use, sometimes without the anchor as in mooring to buoys, while the problems of fouled anchors, foul hawse and lost anchors present concerns for seafarers as well as insurers.

The marine industry employs many types of anchors in a variety of forms. However, the common factor with all anchors is their respective holding power. Historically, anchors have developed through the centuries from the basket of stones of the ancient world’s first ships, through to the hook effect of the “Admiralty Pattern Anchor” and on to the current widely used Stockless anchors.

The massive expansion in offshore environments has probably been the greatest incentive to anchor modernization. The varied types of “Bruce Anchor”, the Flipper Delta anchors and the many mooring type anchors in use, has reflected major development in the mooring of modern day ships.

**Search and rescue system.** The Global Maritime Distress and Safety System (GMDSS) is an internationally agreed-upon set of safety procedures, types of equipment, and communication protocols used to increase safety and make it easier to rescue distressed ships, boats and aircraft.



Ships subject to the Safety of Life At Sea (SOLAS) Convention are to be outfitted with certain communications equipment, collectively referred to as the shipboard portion of the GMDSS. Certain fishing vessels and other marine craft may also be required to carry GMDSS-compatible equipment; and, other vessels may voluntarily carry this equipment. GMDSS is intended to provide: automatic alerting and locating with minimal delay, reliable network of SAR communications, integration of satellite and terrestrial communications, and adequate frequencies in all maritime bands.

Nations establish national (or regional) SAR systems to provide SAR services as part of the global (worldwide) SAR system. SAR services help nations to meet national and international humanitarian and legal obligations. Many States have accepted the obligation to provide aeronautical and maritime SAR co-ordination and services on a 24-hour basis for their territories, territorial seas, and where appropriate, the high seas.

**On-scene coordinator and his duties.** Normally, an OSC will be designated when two or more search and rescue units are involved in a SAR mission. When only one SRU is assigned to a mission it will perform the duties of the OSC. It is the OSC's responsibility to assist in ensuring the search plan is carried out properly by evaluating and, if necessary, making recommendations to the SAR Mission Coordinator to alter the plan. For the maritime environment, ship masters typically perform the OSC function due to ship endurance on-scene unless more capable SRUs are available. The OSC should be the most capable person available, taking into consideration SAR training, communications capabilities, and the length of time that the unit can stay in the search area. Frequent changes in the OSC should be avoided. An OSC conducts the SAR mission on scene using SAR facilities made available by the SMC, and should safely carry out the search or rescue action plan. If the SMC does not provide a sufficient action plan, the OSC must develop a plan and notify the SMC. The OSC retains OSC responsibilities from the time of designation until relieved or mission completion. Frequent changes in OSC assignment are not desirable. Any individual arriving on scene that is senior to the OSC should normally not assume those duties without SMC concurrence. If the senior person concludes that such a change is important to mission success or if the OSC requests to be relieved for good reason and the SMC concur, a change may take place.

**Search and rescue patterns.** Masters of ships called in to act as a search unit or who find themselves designated as an On Scene Co-ordinator (OSC) may find that SAR Mission Co-ordinator (SMC) would provide a search action plan. However, this is not guaranteed, and the choice of the type of search pattern to employ may fall to the individual Master.

Clearly, a choice of pattern will be influenced by many factors, not least the number of search units engaged and the size of the area to be searched. It will need to be pre-planned to ensure that all participants are aware of their respective duties during the ongoing operation. To this end the navigation officers of vessels can expect to play a key role within the Bridge Teams.

At the end of the course, the trainees will be able to:

- ✓ Define all methods of plotting the ships position in all chart systems;
- ✓ Using of all aids to navigation on board;
- ✓ Identify sailing conditions and stage of threat for the vessel;
- ✓ Applying the International regulations for avoiding collision at sea;
- ✓ Revealing the connection between bridge organization and safety of navigation;
- ✓ Organizing the interaction between bridge team members during pilotage;
- ✓ Applying the requirements for sailing in coastal waters under vessel traffic service.

### **3.3 Course no.3: Risk based safety**

This course is designed to provide to management level officers with an in-depth theoretical and practical knowledge of the requirements for risk assessment of different kind of activities and necessary precautions for avoiding casualties. The course is scheduled for 120 hours and offers a number of 8 ECTS. Students shall initially go through a thorough introduction to the problems of risk definition, risk quantitative measurement, analysis of risk as an integral part of all decision making tasks in real life. This shall be performed in the first part of the discipline. The second part of the discipline shall go in the specific details of onboard risk management.

In the course are analyzed risk assessment requirements of ISM Code, all conditions of sailing of vessels, mechanism of risk assessment of the activities on board and applying the regulations of risk based safety in this respect.

The expected objectives of this course must be accomplished through the realization of the main tasks:

- ✓ Introduction to the theory of risk, uncertainty, quantitative measurements of uncertainty and decision making under risk;
- ✓ National and international legislation in respect of risk assessment of company's activities;
- ✓ The concept of the process of risk based safety management in shipping;
- ✓ The elements and benefits of risk based safety management system;
- ✓ Tools for implementing of risk based safety management in shipping;
- ✓ Comprehensive process of risk based safety management and involved activities of vessels at sea;
- ✓ Tools and techniques for managing of the risk based safety process.

Course objectives are touch through the following developed chapters.

**Planning, forecasting, decision making and safety management.** Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. Risk and uncertainty are central to forecasting and prediction; it is generally considered good practice to indicate the degree of uncertainty attaching to forecasts. In any case, the data must be up to date in order for the forecast to be as accurate as possible.

Formal strategic planning calls for an explicit written process for determining the firm's long-range objectives, the generation of alternative strategies for achieving these objectives, the evaluation of these strategies, and a systematic procedure for monitoring results.

Qualitative forecasting techniques are subjective, based on the opinion and judgment of consumers, experts; they are appropriate when past data are not available. Quantitative forecasting models are used to forecast future data as a function of past data; they are appropriate when past data are available. These methods are usually applied to short- or intermediate-range decisions.

**Expert methods for safety assessment – the DELPHI procedure.** The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts. The experts answer questionnaires in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments.

Delphi is based on the principle that forecasts (or decisions) from a structured group of individuals are more accurate than those from unstructured groups. Delphi has been widely used for business forecasting.

The method is widely applied in a variety of areas. First applications of the Delphi method were in the field of science and technology forecasting. The objective of the method was to combine expert

opinions on likelihood and expected development time, of the particular technology, in a single indicator. Later the Delphi method was applied in other areas, especially those related to public policy issues, such as economic trends, health and education.

A number of Delphi forecasts are conducted using web sites that allow the process to be conducted in real-time.

Traditionally the Delphi method has aimed at a consensus of the most probable future by iteration. Other versions, such as the Policy Delphi is instead a decision support method aiming at structuring and discussing the diverse views of the preferred future.

Overall the track record of the Delphi method is mixed. There have been many cases when the method produced poor results.

Another particular weakness of the Delphi method is that future developments are not always predicted correctly by consensus of experts.

**Application of REPOMP procedure in real-life case studies.** Several applications of the REPOMP procedure shall be given during this lecture, and those examples shall facilitate the explanation on the steps of application of the procedure.

The first example to be discussed concerns port infrastructural decision. Four alternatives for the future development of a sea port are described, envisaging different type and extent of changes to the purpose and functionality of the region. One of the alternatives analysed is not to do anything and keep the current status of the port.

The second example discusses two-alternative environmental problem situation. It seeks to answer the question whether municipal solid waste (after separating wastes that can be recycled and used) should be directly disposed or thermally processed first. Those two alternatives will be referred to as “landfill” and “incineration” (although the second alternative also envisages subsequent landfill of the ash). For example, the necessary land space is not defined, as well as its location, the possible liabilities, etc. In this way, the alternative technologies can be characterized only with the help of statistical data.

When reviewing hypothetical version with equal coefficients of significance of the marginal criteria (in real life such a hypothesis is practically impossible) the two alternatives are equivalent and they cannot be ranked with certainty.

The reviewed environmental problem is quite elementary, but it faces all conceptual difficulties that come along with the preliminary screening of alternatives.

The procedure for ranking alternative environmental programs presented here is a flexible generic mechanism for evaluation that can be applied to many different sizes, quantity and significance of input data. Using modern computer intensive simulation tools supports its adequacy and the preciseness of the results, and the final alternative ranking.

**Random variables and uncertainty.** We initially discuss random events. The random event is an event that may or may not occur in a single trial. There are more complex definitions of a random event, for example an union of possible (future) events or scenarios. The impossible and the certain events are extreme cases of random events. The *certain event*  $\Theta$  is also referred to as *the sample space*. It is a random event that always occurs. The *impossible event*  $\emptyset$  is a random event that never occurs. The impossible event is sometimes referred to as the *null event*. Several examples of such events shall be provided

Informally speaking, an rv is a variable that takes an unknown value from a known interval of values. There are three ways to assign a distribution law of a given rv that are most popular: the cumulative distribution function, the probability density function, and the discrete probability function. Each of

these has a specific application area. We introduce their definitions, their form, and main characteristics. It is important to emphasize that the cumulative distribution function applies to all kinds of random variables, whereas density applies to continuous and the discrete probability function only applies to discrete random variables.

Other characteristics answer the question “what is the variability of the random variable”, and they are called measures of variability (variance, standard deviation, interquartile interval, etc.). We go through the different types of numerical characteristics and explain their meaning and application. It is also important to emphasize the problems some characteristics may generate that lead to distorted image of the analysed process. For that reason it is necessary to use a combination of several numerical characteristics.

**Interval probabilities and distributions in the description of real-life uncertainty.** The aim of this chapter is to offer knowledge about: Essence and origin of interval probabilities; Origin of the interval character of probabilities; Influence of interval probabilities over the probability elicitation process; Ribbon distributions as modification of classical distributions; Multi-dimensional distributions - essence and structure; Independence conditions between the attribute; Constructing multi-dimensional distributions.

**Nature of uncertainty and risk analysis.** The main purpose of the theoretical methods and practical approaches to work with probabilities is to elicit the conditional likelihood of the states  $\theta_i$  that result from the chance points, as well as those associated with the events in each lottery. The set of all these estimates form the probability structure of a problem, whereas the process of collecting these probabilities is called probability quantification of uncertainty.

There are problems, where the probabilities of some states in the decision table or some chance points in the decision tree may be directly elicited subjectively by the decision making (or by an expert to whom this task has been assigned by the decision maker) using all the available information. Of course, if information from a repeated identical experiment is available, then it is possible to find the frequencies of these states.

On the other hand, the probabilities of most events are usually very difficult to elicit directly.

The assessment of the probabilities is strongly dependent on the model that binds the easily analyzed input quantities and the output quantities that are important in the problem.

The complexity of the analytical models varies in a wide range. Regardless of their complexity and volume, the statistical pattern recognition (SPR) systems are also analytical models.

The simulation models build upon the concept of risk analysis. They find the connection between the input random variables and the analyzed output variable.

The collected values of the output variable then serve to construct a frequentist distribution. In this sense, risk analysis is a powerful technique for quantification of uncertainty in an arbitrary chance point.

The Hertz-Thomas simulation-based risk analysis applies to classical probability distributions and also generates such, which is why it may be referred to as *classical risk analysis*.

**Simulation techniques.** Statistical simulation methods are a powerful tool in the analysis of complex systems. The most popular among them is Monte Carlo. The numerical techniques that stand behind this method are based on statistical simulation, i.e. on any method that uses random number sequences to conduct a simulation. The essence of the method is that it provides integral measures of uncertainty of the simulated system based on the known uncertainties of its parts. The integral measures are calculated on the basis of a large number of system instances in different pseudo-realities, each defined by a specific set of randomly generated states of its parts.

**Introduction to decision theory.** Choosing between alternatives under risk and uncertainty is a matter of professional and personal importance. There are decision problems that strongly affect the decision maker, and which are very complicated mainly due to the large amount of information that has to be processed. These situations ask for systematic techniques for rational choice that analyze the available information step by step, take into account the objectives of the individual in the problem and in the same time are easy to use and do not require complicated and highly specialized theoretical knowledge from the decision maker. Decision theory has established as a well-developed and easily applicable quantitative analysis approach to support choices between uncertain alternatives using. It is based on utility theory and is part of the scientific discipline, *operations research* that evolved after World War II. Its key feature is the ability to define an adequate decision criterion that accounts for the subjective preference, risk attitude and expectations.

There exist other approaches to individual decision making, such as interactive multi-objective programming, analytical hierarchy process (AHP), Markov decision processes, Markov flows over graphs, Pareto analysis, multi-criteria decision making (MCDM), fuzzy logic, etc. Those techniques shall be given explanation on their essence during the lecture, and a comparison with the particular decision techniques shall be provided.

There are empirical proofs regarding inconsistencies between normative behavioral decision rules and actual preferences declared in the subjective measurement process that are the basis of the analysis. This fact is a major obstacle before the wider application of decision theory.

**Modeling decision problems.** In real life problems, decision makers face the necessity to choose between several courses of action, which in turn leads to another choice in time, and so on. The possible *consequences* of the choice form a set  $X$ , and the decision maker receives one regardless of her wish. Instead, the decision maker may and should choose exactly one alternative out of a *set* (of possible) *alternatives*  $L$ . The consequences from the choice of an alternative from  $L$  depend on random events, called *states*, which are also out of the control of the decision maker. As a rule, a single event occurs and it defines the consequence. It is obvious that consequences are a result of decision maker's choice, and in the same time defined by the combination of random factors that model a given state. The structure of consequences should be defined so as to describe all aspects of the problem that are of importance for the decision maker. It should also show the extent to which the result of the decision meets all significant objectives of the decision maker, described by measurable parameters. That is why a typical form of the consequences is a multi-dimensional vector, whose coordinates (components) equal to the values of these parameters.

**Modeling risky alternatives through ordinary lotteries.** Lotteries are the formal representation of risky alternatives in decision analysis. In this lecture we discuss the first type of lotteries – ordinary lotteries and their possible types.

Strictly speaking, those two model are representation of simple ordinary lottery, but the models of finite compound ordinary lottery follow exactly the same ideas.

Often there are more complex gambles that can be presented by *compound ordinary lottery*, where some of the “prizes” are an entry into another ordinary lottery. Compound ordinary lotteries are usually denoted by a capital letter  $L$ , always with uppercase/lowercase indices. If the outcomes of a compound ordinary lottery are only prizes or simple ordinary lotteries, then it is called one-time compound ordinary lottery. If the outcomes are only prizes, simple ordinary lottery or one-time compound ordinary lotteries, then it is called two-times compound ordinary lottery. After a single randomization that governs an ordinary lottery, it results in either a prize from  $X$  or an (obligatory)

entry into another ordinary lottery. Those are the *direct outcomes* of an ordinary lottery. The *ultimate prizes* of an ordinary lottery are all members of  $X$  that result from an ordinary lottery once the entire uncertainty has been resolved.

**Choosing ordinary lotteries.** This chapter is dedicated to themes like: Choosing between ordinary lotteries; Axioms of rationality; Existence of the utility function over ordinary lotteries; Choosing generalized lotteries; Axioms of rationality and, Existence of the utility function over generalized lotteries.

**Uniqueness of the utility function over lotteries.** Consider a utility function that agrees with the preferences of a given decision maker over a set of prizes. Assume that all values of that function were multiplied by a given positive number and then another real number was added as a result of which anew utility function over the set  $X$  is defined (this procedure is called positive affine transformation of the utility function). It turns out that the order of values of the initial and the transformed utility functions over the set of prizes will be the same; furthermore the order of expectations of both functions over the set of alternatives (lotteries) will also be the same. Thus, a transformation of that kind does not change the information the utility function carries. It follows that the transformed function may serve to rank any prizes according to preference and rank any lotteries according to expected utility (i.e. according to the expectation of the utilities of their prizes). Evidently, the new function may be analyzed as an utility function. Therefore, if the decision maker abandones the probability interpretation of utility then there will be more than one utility function that agrees with her preferences. This assumption is the essence of the theorem for uniqueness of the utility function in the case of ordinary lottery.

**Decision criteria under non-monotonic preferences.** The aim of this chapter is to give students insight into the following topics: Essence of decision criteria under non-monotonic preferences; Origin of non-monotonic preferences; Types of non-monotonic preferences; Approach to construct the utility function under non-monotonic preferences.

**Decisions under partially qualified uncertainty.** Utility theory represents uncertain alternatives as lotteries interpreting the relationship between states and prizes. In a problem under risk, the uncertainty is entirely measured by classical distributions, whereas the preferences over prizes – by a utility function. The resulting classical risky lotteries are ranked according to expected utility.

The uncertainty in the alternatives that the fuzzy rational decision maker faces can only be partially measured by ribbon probability distributions. These alternatives cannot be adequately modeled by classical risky lotteries, not to mention being ranked according to expected utility. In this section, the alternatives that the fuzzy rational decision maker faces shall be modeled by *fuzzy rational lotteries*, where the uncertainty is only partially measured by ribbon distributions. The fuzzy rational alternatives are ranked in two stages.

In the first stage, the ribbon distribution is approximated by a classical one. This is a task under strict uncertainty since any classical distribution that belongs to the ribbon distribution is just as likely as the other ones. The main idea is to use any of the  $Q$  criteria under strict uncertainty at that stage. The resulting approximating lotteries are called *Q-lotteries* and are classical risky.

At the second stage, the *Q-lotteries* should be ranked. The expected utility rule applies here since this is a problem under risk. The expected utility of the *Q-lotteries* is called *Q-expected utility* of a fuzzy rational lottery.

This two-stage procedure to rank fuzzy rational lotteries is equivalent to the introduction of a ranking criterion, called *Q-expected utility*.

**Ribbon risk analysis.** Strictly speaking, a ribbon distribution consists of multiple equally likely classical distributions lying within its bounds. This means that now each input random variable may be probabilistically described by a set of classical distributions, instead of a single one. Therefore the computer simulation steps mentioned above need to be performed multiple times for multiple random combinations of classical distributions of the input random variables. In that way, a single output classical distribution shall correspond to each combination of input classical distributions.

At the end of the analysis, a ribbon distribution of the output random variable can be constructed, such that its lower and upper bounds form an envelope of all output classical distributions generated during simulation. In other words, the classical risk analysis transforms into risk analysis of the risk analysis. This procedure shall be referred to as *ribbon risk analysis*.

**Introduction to the navigational risk assessment process.** This module aims to prepare students for a performance of risk assessment process applying the most popular models for the process.

The module is logical continuation of the previous module lessons. In the previous lessons students acquire skills to use different mathematical and logical methods for estimating the risk in different situations and conditions. In this module they have to learn the place of the models studied in the general navigational risk assessment model.

As a result of the module the students have to know: How to apply the traditional navigational risk assessment model; How to elaborate scenarios of the navigational aspects of different maritime facilities technological processes; How to elaborate risk matrix applicable for different situations; How to assess existing management strategies and to develop new measures; How to perform risk assessment in complex situations.

**Elaboration of navigational object passport.** Data Gathering and System Assessment comprises a review of any historical incidents data and/or database, pilotage, the vessel traffic management that it is in place, as well as any procedures or requirements managing navigation.

When speaking of a maritime installation we prepare so called object passport. The passport has to explain: Location of the object including geographical location and borders; Technological process (maritime aspects); Surrounding areas including explanation of the purpose of the surrounding objects and their technological processes; Area conditions including navigational environment, geographical factors, weather conditions.

**Hazard identification (HAZID).** Hazard Identification (HAZID) is performed during the navigational risk assessment. HAZID is performed on the background of descriptions of the technology of the processes.

For the purpose of the navigational risk assessment HAZID includes the following steps: Decomposition of the technology processes into phases and stages. The phases and the stages are defined taking into account particularity of the technology activities and areas; Description of critical events (navigational hazards) related to the phases and stages of the processes; Description of hazards. A general event tree (fault tree) is elaborated for any category of accident. The general fault trees in fact decompose composite events into single events (hazards). The fault trees are modified for any particular scenario. The trees are inseparable part of the hazard scenarios.

The frequency and consequences of any hazard is assessed on the background of the scenarios. The assessment of the hazard frequency is done qualitatively on the base of the qualitative data for single (basic) hazards. The necessary data for qualitative assessment of the single event hazards is defined as an output of the fault trees of any particular scenario. The qualitative data is of different types: acquired statistics, estimated probabilities, intensity of flows (traffic density), frequency of occurrence (weather conditions).

**Scenario elaboration.** HAZID process is conducted on an Incident Category basis. Categorization is on the base of decomposition of the technology processes into phases and stages. Accidents are categorized into the following groups: Collision; Grounding; Weather conditions; Lose of steering or propulsion; Damage of facilities.

On the basis of the phases and stages a scenario is elaborated for any type of the accident. Any scenario has its own ID number. A data is to be acquired for any type of accident.

**Matrix of critical events.** For the purpose of the current navigational risk assessment HAZID includes the following steps:

1. Decomposition of the technology processes into phases and stages. The phases and the stages are defined taking into account particularity of the technology activities and areas.
2. Description of critical events (navigational hazards) related to the phases and stages of the processes.
3. Description of hazards.

For the purpose of matrix of critical events elaboration the following recommendations are to be followed:

Recommendation 1: Legend for “Scenario ID”

Recommendation 2: Additional abbreviations.

**Fault tree.** A general event tree (fault tree) is elaborated for any category of accident. The general fault trees in fact decompose composite events into single events (hazards). The fault trees are modified for any particular scenario. The trees are inseparable part of the hazard scenarios.

The frequency and consequences of any hazard is assessed on the background of the scenarios. The assessment of the hazard frequency is done qualitatively on the base of the qualitative data for single (basic) hazards. The necessary data for qualitative assessment of the single event hazards is defined as an output of the fault trees of any particular scenario. The qualitative data is of different types: acquired statistics, estimated probabilities, intensity of flows (traffic density), frequency of occurrence (weather conditions).

The typical perspectives of the consequences are the following categories: Risks to People; Risks to Property; Risks to Environment; Risks to Harbour Stakeholders.

**Scenario elaboration for bad weather conditions.** For the scenario elaboration specific information about meteorological and hydrological information is necessary. The following data is necessary: Hydro-meteorological Environment; Wind; Gales; Sea Waves; Swell; Currents; Tides; Fogs; Icing; Thunders.

**Scenario elaboration for collision.** Collision is a compound event which is result of the following single events: Loss of steering; Loss of propulsion; Tug accident; Dangerous maneuvering (Ship in the vicinity); Small vessel breaking rules (Small Vessel); Ship breaking rules; Wind above ?? m/s; Waves above ? m.; Visibility under ??? m.



These single events can be grouped in the following compound events: Uncontrolled movement; Dangerous maneuvering (Obstacle on course); Adverse weather.

**Scenario elaboration for grounding.** Grounding is a compound event which is result of the following single events: Loss of steering; Loss of propulsion; Tug accident; Dangerous maneuvering (Ship in the vicinity); Ship breaking rules; Wind above ?? m/s; Waves above ? m.; Visibility under ???? m.

These single events can be grouped in the following compound events: Uncontrolled movement; Dangerous maneuvering (Obstacle on course); Adverse weather.

**Scenario elaboration for navigational accident (damage).** Navigational accident (damage) is a compound event which is result of the following single events: Tug accident; Tug unavailable; Wind above ?? m/s; Waves above ? m; Visibility under ????m.

It also can be result of some compound critical events as: Grounding; Collision.

**Risk analysis.** In fact the risk assessment starts with identification of hazards. The most wide spread definition of hazard is an event that can cause harm to: People; Environment; Property; Harbour stakeholders.

In fact the harm to people, environment, property and stakeholders constitutes the four aspects of risk assessment.

In order to estimate the risk the frequency and consequence data should be taken into account. This makes the risk a combination of: The frequency (likelihood, probability or chance) of a hazard realization; The consequence (severity or impact) of the hazard reaching its potential.

The result of any hazard realization is related with a statistics of consequences. It is important to be noted that the relationship between frequency and consequence is different across the range of possible accidents and their outcomes.

Classically there are two types of risk assessment - qualitative and quantitative.

**Risk components.** The risk is a combination of:

1. The frequency (likelihood, probability or chance) of a hazard realization;
2. The consequence (severity or impact) of the hazard reaching its potential.

The result of any hazard realization is related with a statistics of consequences. It is important to be noted that the relationship between frequency and consequence is different across the range of possible accidents and their outcomes.

The frequency scale that is used can be different. Because of the specific of navigational activities we have different frequencies within one astronomical year. The ups and downs in maritime activities within a year are usually result of the weather conditions, distribution of stock flows etc.

This makes the most common statistical period to be with duration of one operational (astronomic) year.

When discussing the hazard we pointed that the hazards has to be assessed in four perspectives: people; environment; property; harbour stakeholders.

**Risk matrix.** There are many advantages of the Risk Matrix. The main strengths are the following:

- It is easy to apply;
- It is easy to understand;
- It allows risks to people, property, environment and operations to be treated consistently;
- It allows ranking the hazards in priority order for risk reduction process.

The main disadvantages of the approach are due to the qualitative nature of the risk assessment process.

The Risk Matrix Methodology is broadly used by the offshore industry for such tasks as rig moves, anchor recovery, anchor deployment and towage. It has been proven as a useful tool for reduction of the risks during the last ten years and appears to be suitable for the case study Navigation Risk Assessment as developed in practical exercises and lectures.

**Assessment of existing management strategies, development of new measures.** These activities are performed during stage 4 of the navigational risk assessment process. Once the risks are scored, the process of risk mitigation can begin. The hazards showing the highest risk ranking are of highest priority. The causal information is used to develop new or improve existing risk management systems. Following the event sequence of any scenario are performed the following activities:

- a. Assessment of adequacy of existing safety measures.
- b. Identifications of faults of existing safety measures.
- c. Development of new measures for reducing the risk to an acceptable level.
- d. Assessment of residual risk.

**Reporting results of navigational risk assessment.** The output of the navigational risk assessment is presented in a report. The structure of the report is the following: DESCRIPTION OF THE ENVIRONMENT, OPERATION DESCRIPTION, METHODOLOGY FOR RISK ASSESSMENT, HAZARD IDENTIFICATION AND RISK ANALYSIS, RISK MITIGATION PLAN, CONCLUSIONS.

At the end of this course, those who successfully complete will be able to:

- ✓ Identify the risk in every ships activity;
- ✓ Apply the theory of risk assessment;
- ✓ Take necessary measures for mitigation of the risk;
- ✓ Apply the practical experience in risk based safety management;
- ✓ Design a new risk based safety management system on board of a ship.

### ***3.4 Course no.4: Security awareness in piracy areas***

This course aims to give the trainees profound knowledge and enough practice-theoretical experience considering one of the most challenging threats to the maritime security: Piracy. Those crime acts continue to be very costly for the commercial maritime industry and involve the use of various tactics and platforms which present a challenge to ships and ports. Equally concerning, though is the trend which points to an ever-increasing potential for violence.

The lectures and seminars have developed for 120 hours (8 ECTS) and have the aim to define piracy as a risk for the maritime security through analyzing its genesis, types and geographical areas, and the negative impact and consequences on the worldwide shipping. The rise of the piracy attacks in the recent years has prompted the international community to undertake a set of different measures for countering acts of piracy. The current tendencies, legal documents and the national and international piracy counter-measures with lot of practical examples will be reviewed.

The expected objects of this course must be accomplished through the realization of the main tasks:

First - those who successfully complete this course will claim knowledge about:

- ✓ The current global maritime security threats;
- ✓ The Maritime Terrorism, Illegal smuggling and Migration and Refugee problems;
- ✓ Piracy as a threat to the maritime security;

- ✓ The negative impacts of piracy on the maritime security;
- ✓ The geography of piracy and the Risk Areas- Gulf of Aden, Strait of Malacca, Gulf of Guinea;
- ✓ UN and IMO Anti-Piracy Politics and IMO Piracy Related Documents;
- ✓ NATO Anti-Piracy Politics and Measures and NATO Shipping Centre;
- ✓ EU Anti-Piracy Politics and EU Operation NAVFOR;
- ✓ The link between State Failure and Piracy in the affected areas;
- ✓ The linkage between piracy, terrorism and organized crime;
- ✓ The actual effects of the anti-piracy measures of the international community on the maritime security;
- ✓ The Tactics of the Pirate Attacks;
- ✓ Risk Assessment for Company planning and Ship Masters Planning;
- ✓ Anti-Piracy reporting procedures and anti-piracy ship protection measures;
- ✓ Post Incident reporting and investigation procedures;
- ✓ Naval Co-operation and Guidance for Shipping (NCAGS) mission, operations, communication organization, procedures and protective measures for merchant ships;

The course content is structured in the following chapters.

**Maritime security threats.** The aim of this chapter is to outline the contemporary maritime security threats in the new advanced surroundings. Apart from state adequate control over the impact over the presence, security can be interpreted as a state of equilibrium between the threats and capacity for response to the threats. Following this logic, the main challenge facing the countries is how to increase their capacity for achieving a better level of security and at the same conducting a policy aimed at improving the common environment for maritime security. For the Mediterranean and Black sea regions for example, burdened from a lot of information considering the historical and geographical data which generates contradictions, the is not another choice but to seek more efficient integration of institutions and communities, which possess a great capacity for accomplishing security, such as European Union and NATO.

**The global threat of terrorism.** In today's world, *piracy and maritime terrorism* are among the most dangerous international maritime crimes which violate freedom of navigation; distorting international trade, threatening the peace, security and safety of maritime and air routes and the lives of passengers and crews. This chapter will be an introduction to terrorism as a threat to maritime security.

The increased activity of terrorist organizations against military targets at sea is undeniable proof of naval potential. Its basis are as separate naval units and commercial vessels.

Part of the terrorist organizations have their own merchant fleet, vessels flying the flags of Panama , Honduras, Liberia , Cyprus and Malta. During most of the time they carry general cargo, which serves as a cover for the transportation of arms, ammunition and explosives.

Tactical forms used by terrorists conditionally divided into: Management of ships and other marine structures in order to hostage-taking; Blows (blow) of ships at sea; Blows (blow) of ships in port and at anchor; Blows (blowing) of port facilities and other coastal sites.

**Illegal smuggling at sea.** In this chapter we review one of the current maritime security threats - the illegal smuggling at sea, especially its regional dimension. The main factors influencing the activation of this criminal activity is associated with economic difficulties and the slow restructuring of state control institutions. Furthermore, the effects of the wars in the former Yugoslavia, the chaos in the

emerging countries of the former Soviet Union and the specific transport infrastructure in the Balkans further create conditions in which organized crime was able to achieve significant impact on border controls and adjacent corridors.

The analysis of this negative impact on security in the Black Sea region requires special attention to the smuggling of cigarettes, alcohol and petroleum products, focusing on marine aspects of this criminal activity.

**Illegal migration and refugee.** Serious challenges, risks and threats to security can be generated *from human trafficking and illegal migration* from and through the Black Sea region. The main problems that provoke these illegal activities are the demographic boom, regional conflicts, poverty and others. They are with long term nature and cannot be solved quickly, which means that the negative impact cannot be easily overcome, despite national and international efforts. The aim of the lecture is to present both the key issues and to pave the way refugee flows present.

To illicit trafficking by sea can be assigned any actions of organizations and individuals carried out on the three known process: illegal boarding of civil ships (stowaway); pay for seafarers to hire craft and implement sea freight and illegal landing on the coast of pre-selected state, and theft of vessels to perform illegitimate transfer of large groups of people at sea.

**Piracy: Definition and the negative impact on security.** Piracy, the former of which can be traced back to 1200 b.c., continues to be costly scourges for the commercial maritime industry and involve the use of various tactics and platforms which present a challenge to ships and ports. Equally concerning, though is the trend which points to an ever-increasing potential for violence. In this chapter we review the definition and brief history of piracy. We outline the issue as one of the current global challenges for the maritime security.

**The geography of piracy.** The threat of maritime piracy has mushroomed enormously in the past few years. The news channels on a daily basis have a new incident to report about pirates attacking a crew and looting the vessel or hijacking a ship, and even causing harm to the crew when their ransom demands are not met by the authorities. The aim of the chapter is to review the geography of the current piracy activities.

**Piracy in the Gulf of Guinea: Nigeria.** The aim of the chapter is to give an overview of the piracy acts and incidents in the Gulf of Guinea with some information on the causes and national and international counter-measures.

**Piracy in the Strait of Malacca.** The Strait of Malacca's geography makes the region very susceptible to piracy. It was and still is an important passageway between China and India, used heavily for commercial trade. The strait is on the route between Europe, the Suez Canal, the oil-exporting countries of the Persian Gulf, and the busy ports of East Asia. It is narrow, contains thousands of islets, and is an outlet for many rivers, making it ideal for pirates to hide in to evade capture.

The aim of the chapter is to give an overview of the piracy acts and incidents in the Strait of Malacca with some information on the causes and national and international counter-measures.

**Piracy as a problem of global governance and international cooperation: United Nations Anti-Piracy Politics.** In this chapter we review the piracy as a global recognized challenge for the world

maritime security. We look on the current politics of the biggest international organization, the United Nations, and the adopted measures of the international community.

**IMO Anti-Piracy Politics.** In this chapter we review the anti-piracy policy of the International Maritime Organization, the leading international organization in maritime affairs. While there can be no doubt that the eventual solution lies in restoring effective governance in Somalia, the International Maritime Organization (IMO) has, in the meantime, taken a leadership role in coordinating efforts to alleviate the problem from the maritime perspective.

IMO is implementing an anti-piracy project, a long-term project which began in 1998. Phase one consisted of a number of regional seminars and workshops attended by Government representatives from countries in piracy-infested areas of the world; while phase two consisted of a number of evaluation and assessment missions to different regions. IMO's aim has been to foster the development of regional agreements on implementation of counter piracy measures.

To assist in anti-piracy measures, IMO issues reports on piracy and armed robbery against ships submitted by Member Governments and international organizations. The reports, which include names and descriptions of ships attacked, position and time of attack, consequences to the crew, ship or cargo and actions taken by the crew and coastal authorities, are now circulated monthly, with annual summaries.

**Piracy as a problem of military coordination, surveillance and deterrence: NATO Anti-Piracy Politics.** Piracy in the Gulf of Aden, off the Horn of Africa and in the Indian Ocean is undermining international humanitarian efforts in Africa and the safety of one of the busiest and most important maritime routes in the world – the gateway in and out of the Suez Canal. NATO has been helping to deter and disrupt pirate attacks, while protecting vessels and helping to increase the general level of security in the region since 2008. In this chapter we review the anti-piracy policy of the NATO, the Euro-Atlantic collective security organization.

**The regional approach: EU Anti-Piracy Politics.** The European Union is concerned with the effect of Somali-based piracy and armed robbery at sea off the Horn of Africa and in the Western Indian Ocean. Somali piracy is characterised by criminals taking control of vessels transiting the High Risk Areas in the Region and extorting ransom money for the crew, the vessel and cargo; this bearing all features of organised crime. Crews held hostage by pirates often face a prolonged period of captivity, the average being 5 months (145 days) but some hostages have been held for more than two years and eight months (1001 days). Moreover, piracy impacts on international trade and maritime security and on the economic activities and security of countries in the region.

As a result, and as part of the Comprehensive Approach to Somalia, in December 2008 the EU launched the European Union Naval Force (EU NAVFOR) Somalia – Operation Atalanta within the framework of the European Common Security and Defense Policy (CSDP) and in accordance with relevant UN Security Council Resolutions (UNSCR) and International Law in response to the rising levels of piracy and armed robbery off the Horn of Africa and in the Western Indian Ocean. In this chapter, we review the European Union's Comprehensive approach against piracy and the counter-piracy operation off the coast of Somalia –Operation Atalanta.

**Piracy and State Failure in the Gulf of Aden.** This chapter explores the problems experienced by Somalia as a failed state, and the impact of piracy on international commerce and maritime security. Somalia has been unwilling or unable to combat piracy within its waters. Its lack of central

governance limits the country's capacity to tackle onshore piracy. Furthermore, the active offshore piracy that is taking place in the Gulf of Aden provides a clear indication of the state of anarchy within Somalia. It is not possible to confront piracy without addressing the collapse of the Somali state and the inherent poverty, governance issues, and absence of the rule of law in this troubled region. In addition, the ongoing civil war in Somalia has led to the internal displacement of millions of people, making the country a refuge for suspected terrorist organizations. The international community must play a role in peace-building and state reconstruction to enable Somalia to deal with piracy in a meaningful and effective way.

**State Failure in Nigeria.** The aim of the chapter is to give a historic overview and background of some state defects in Nigeria and to examine the level of state failure.

**The linkage between piracy, organized crime and terrorism.** The linkage between piracy and organized crime has become clear over the past 10 years, and the thin line between certain incidents of piracy and terrorism has become increasingly blurred.

Case studies of piracy incidents in the past decade, specifically in Southeast Asian and African waters, reveal increasing sophistication in tactics and equipment and, moreover, highlight the high level of logistics and international coordination effected by these international criminals. With increasing frequency, entire ships and their cargoes have been stolen, the ships repainted and reflagged, new documentation issued, and the cargoes sold to international buyers. Just the reflagging and issue of new vessel documentation requires conspiratorial participation by government authorities, ship management companies, and other shipping entities—demonstrating a diverse breadth of international contacts. While procuring information on cargoes loaded on a specific ship is easy, the sale of an entire shipload of cargo again requires black market access, and most probably in these cases the pirates are truly the operational arm of a transnational criminal organization. Additionally, the numerous cases of ships being seized for the sole purpose of holding the crew hostage—to negotiate a ransom—demonstrate, as in the cases of entire ships stolen, the high level of planning, preparation, and international coordination implemented by and capabilities of these pirate organizations.

**Modern piracy.** This chapter aims to prepare students meet the challenges of modern piracy and to provide anti-piracy security measures using the modern anti-piracy system.

The module is logical continuation of the previous module lessons. In the previous lessons students acquire theoretical knowledge about the world and European maritime security system. In this module they have to learn practically oriented technics for defending shipping against the modern piracy.

**Anti-piracy maritime system. General description.** Regional cooperation among States has an important role in solving the problem of piracy and armed robbery against ships, as evidenced by the success of the regional anti-piracy operation in the Straits of Malacca and Singapore. A good example of successful regional cooperation is the Regional Cooperation Agreement on Combating Piracy and Armed Robbery against ships in Asia (ReCAAP), which was established in November 2004 by 16 countries in Asia. ReCAAP includes the ReCAAP Information Sharing Centre (ISC) for facilitating the sharing of piracy-related information.

The link between NATO naval forces and the merchant shipping companies is the NATO Shipping Centre (NSC). The NSC is the primary point of contact for the exchange of merchant shipping information between NATO's military authorities and the international shipping community. The NSC

is the primary advisor to merchant shipping regarding potential risks and possible interference with maritime operations.

**Anti-piracy maritime system. Recommended documents.** The aim of Industry Best Management Practices (BMP) is to help the ships to avoid delay from piracy attacks in the High Risk Area. The gained experience and the data, collected by Naval/Military forces, shows that the application of the recommendations contained within the BMP will make a significant difference in preventing a ship to become a victim of piracy. For the aims of BMP the term ‘piracy’ includes any acts of violence against ships, the crew and cargoes, including armed robberies and attempts to get on the ship and take control over the ship, where this is possible to happen. Additionally the BMP uses term “pirated” instead of “hijacked” ships.

**Modern piracy tactics.** The presence of Naval forces in the Gulf of Aden is concentrated on the Internationally Recommended Transit Corridor (IRTC). It has significantly reduced the incidence of piracy attack in this area. The activity of the Somali pirates has been forced out into the Arabian Sea and beyond. Somali based pirate attacks have taken place throughout.

The Gulf of Aden, Arabian Sea and Northern Indian Ocean, has a great influence on all shipping in the region. The recent increase in the use of hijacked merchant ships, fishing vessels and dhows as ‘Mother ships’ gives pirates the opportunity to work at extreme range from Somalia, carrying attack craft (skiffs) and weapons.

Mother ships are used for carrying pirates, stores, and fuel and attack skiffs to enable pirates to operate over a larger area, significantly less affected by the weather. Attack skiffs are often towed behind the Mother ships. Skiffs are increasingly being carried onboard and camouflaged to reduce chances of interdiction by Naval forces when the size of the Mother ship allows it.

**Risk assessment. Company planning.** Before entering a High Risk Area, ship operators and Masters should make a Risk Assessment to assess the likelihood and consequences of piracy attacks to the vessel, based on the latest available information. This information can be received through a contract with MSCHOA, NATO Shipping Centre, UKMTO and MARLO). The result of this Risk Assessment should determine measures for prevention, mitigation and recovery, which will lead to a combination between the statutory regulations and supplementary measures to combat piracy.

The Risk assessment is performed by the company and the Master. Nevertheless that two types of Risk Assessment overlaps they have to be carried by the both sides.

The risk assessment has to take into account the ship and the voyage specifics and the recommendation of the ISPS Code and other documents.

**Risk assessment. Ship Master’s Planning.** The risk assessment has to take into account the recommendation of the ISPS Code and the voyage specifics and other documents

The Master’s Risk Assessment includes: The threat; Background factors shaping the situation; Possibilities for co-operation with military; The ship’s characteristics/vulnerabilities/inherent capabilities to withstand the threat; Ship’s procedures.

**Anti-piracy reporting procedures.** The reporting procedures are essential for the overall process of countering piracy. Although this could change in the future, at the moment there is no centralized procedure for reporting the movement of ships in the Gulf of Guinea region. However, individual flag states may have their own national ship movement reporting procedures. This is the reason for the

explanation of the reporting procedures in the Gulf of Aden. One of the essential parts of BMP which is applicable for all ships, is the communication with Naval forces. This is for the reason to guarantee that the Naval forces are formal with the sea passage and that the ship is on its way and how vulnerable that ship is to a pirate attack. This information is essential for the reason to be given an opportunity to the Naval forces to use the best assets available to them. After the ships have started their passage it is important that they should continue to update the Naval/Military forces on progress. The two key naval organizations to contact in the Gulf of Aden are the UK Maritime Trade Operations (UKMTO) and the Maritime Security Centre – Horn of Africa (MSCHOA).

**Anti-piracy ship protection measures.** It is recommended for the ship to make preparations to support the requirement for increased vigilance before entering the High Risk Area.

The bridge is usually the focus of every pirate attack. At the beginning of the attack the pirates start an open fire on the bridge in an attempt to try to force the ship to stop. If they are in a condition to get on board, pirates usually try to make the bridge in order to have the opportunity to take over the control.

To deter or delay pirates who have managed to board a vessel and are trying to enter accommodation or machinery spaces it is very important to control access routes. It is very important to recognize that if pirates do gain access to the upper deck of a vessel they will also try to gain access to the accommodation section and in particular the bridge.

The use of water spray and foam monitors is an effective mean for preventing or delaying pirates attempting to board. The use of water can make it difficult for a pirate skiff to remain alongside and makes it significantly more difficult for a pirate to try to climb onboard.

Manoeuvring is one of the most recommendable tactics. Practicing maneuvering prior to entry into the High Risk Area is recommendable. Combination of manoeuvring and other means is the most effective way for preventing access.

**Countering Piracy attacks.** The piracy attacks have two typical stages: approaching stage and attack stage.

There are specific actions that are recommended to be fulfilled during the approaching stage and the attack stage. It is very important to highlight that pirates usually do not use weapons while they are within two cables of a vessel. This means that any period until this stage can be considered as ‘approach’, and gives a vessel valuable time to activate the ship’s protecting measures and to make the pirates clear that they have been noticed and the ship is ready to defend itself.

Additional attention is to be paid to the case if pirates gain control over the ship.

**Post incident reporting and investigating piracy attacks.** Following any piracy attack or suspicious activity, it is vital that a detailed report of the event is provided to UKMTO and MSCHOA. It is also helpful to provide a copy of the report to the IMB. It is important that the report contains descriptions and distinguishing features of suspicious vessels that were observed. This HAVE TO ensure full analysis and trends in piracy activity IF established and MUST enable assessment of piracy techniques or changes in tactics, in addition to ensuring appropriate warnings can be issued to other merchant shipping in the vicinity.

FOR SURE the ship operators may also be required to forward a copy of the completed standardized piracy attack report to their Flag State, and in any event SHOULD do so.

**Naval Co-operation and Guidance for Shipping (NCAGS).** The MAIN REASON of the Naval Co-Operation and Guidance for Shipping (NCAGS) manual is to provide information to Ship Owners,



Operators, Masters and Officers regarding the interaction between Naval forces and commercial shipping. In particular, the publication serves as a handbook for the world-wide application of NCAGS principles and procedures that exist to enhance the safety of shipping in times of tension, crisis, or conflict.

The mission of NCAGS is to provide support to military commanders and merchant shipping in peacetime, tension, crisis and conflict through co-operation, guidance, advice, assistance and, where necessary, supervision. Additionally, to provide military guidance, advice or assistance in respect of participating nations' global, maritime commercial interests to enhance the safety of merchant vessels and to support military operations.

**NCAGS operations. Operation Ocean Shield and Operation Atalanta.** Since August 2009, NATO warships and aircraft have been patrolling the waters off the Horn of Africa as part of Operation Ocean Shield. Their mission is to contribute to international efforts to counter maritime piracy while participating in capacity building efforts with regional governments. Operation Ocean Shield cooperates closely with other naval forces including US-led maritime forces, EU naval forces and national actors operating against the threat of piracy in the region. On 19 March 2012, the North Atlantic Council extended the operation until the end of 2014.

As a result of the Comprehensive Approach to Somalia, in December 2008 the EU launched the European Union Naval Force (EU NAVFOR) Somalia – Operation Atlanta within the framework of the European Common Security and Defense Policy (CSDP) and in accordance with relevant UN Security Council Resolutions (UNSCR) and International Law in response to the rising levels of piracy and armed robbery off the Horn of Africa and in the Western Indian Ocean. Operation Atlanta is the European Union's counter-piracy operation off the coast of Somalia.

**NCAGS – Communication organization.** Merchant vessels SHOULD normally communicate with military forces using standard peacetime methods. In some situations, restrictions on electronic emissions may be required when approaching or when transiting an Area of Operations (AOO). Instructions for use of non-standard communications methods will be provided as necessary.

**NCAGS – Procedure for merchant ships.** The Master is at all times responsible for the safe navigation and handling of his ship.

Crisis Response Shipping will usually be obtained from commercial charter and Masters of such vessels should be fully informed of their Charter Party. It may contain specific conditions related to the use of the ship in a military environment.

It is the Master's responsibility to ensure that all appropriate crew members are fully acquainted with the instructions necessary for the efficient performance of any communication duties including adherence to the Emission Control (EMCON) policy.

Occasionally, when a merchant ship is working with military, classified material may be carried on board. Such sensitive material is usually in the custody of embarked NCAGS Liaison Officer and requires special handling and precautions.

**NCAGS – Protective measures against threats to merchant ships.** The purpose of this chapter is to identify the various types of threats to give general advice on how to avoid threat and to outline measures to protect and ways to counter the effects of an attack. Detailed information about specific threats can be provided by military advisers (Liaison officers).

There are minimal protective measures available to commercial vessels that are usually unarmed, have a small crew and limited civilian regulations. Situational awareness is necessary if the master is to resist or avoid the threat or mitigation. This includes knowledge of the threat and the presence of friendly forces or authorities, which can be connected to provide support. It also includes a knowledge of the individual preparations may be administered before the entry area of the threat.

At the end of the course, those who successfully complete this course will be able to:

- ✓ Define the current global maritime security threats;
- ✓ Analyze the potential threat of terrorism, the negative impact of organized crime, illegal smuggling and illegal migration;
- ✓ Define the piracy and its current dimensions;
- ✓ Analyse the negative impact of piracy on the maritime security;
- ✓ Making valuation of the piracy threats in all affected areas;
- ✓ Define the scope of the international anti-piracy politics ;
- ✓ Define the legal aspects of the international organizations anti-piracy measures;
- ✓ Specify the anti-piracy politics on global and regional level;
- ✓ Define “state failure” and the political-economic factors for piracy;
- ✓ Prepare risk assessments for company and ship masters planning;
- ✓ Use the Anti-Piracy reporting procedures;
- ✓ Organize post incident reporting;
- ✓ Define and Use of Naval Co-operation and Guidance for Shipping (NCAGS);
- ✓ Reacting in different situations of Maritime Security Threats.

### **3.5 Course no.5: Special ships operations**

The course aims to understand the suitability of specific ship types for different activities and operational ways to complete their missions.

The course is structured for 120 hours of lectures and seminars with 8 ECTS and dedicated to operation of ships used for special purposes and with particular operational characteristics.

Having successfully completed the course, the student will be able to demonstrate knowledge and understanding of:

- ✓ Operation of ships in offshore activities
- ✓ Operation characteristics of research vessels
- ✓ Ships operation in polar waters
- ✓ Green ship concept
- ✓ Operation of ships with special propulsion systems

Starting from these considerations, the developed teaching materials was structured in chapters as follows.

**Introduction in special ships operation.** As the name already suggests, this type of vessels are at sea for a special purpose. Their primary task is drilling for oil, laying cables, creating artificial islands, laying cables, installing wind turbines, an so on. These ships should be able to sail the sea as efficient and safe as possible, but should also be able to be keep position or to follow a certain track while on the job. The typical full hull form of these type of vessels, the use of thrusters and nozzled propellers and the requirements on dynamic positioning and workability require a special approach with respect to design, calculations and model tests. Issues which are usually addressed are flow separation,

dynamic positioning capability, thruster-thruster and thruster-hull interaction, moonpool oscillations, loads on legs of jack-up vessels, seakeeping behaviour at transit and zero speed and dynamic tracking. The development of offshore oil and gas fields involves a wide range of marine assets. The variety of offshore vessel types can be confusing to some readers. This chapter sets out the main categories of vessels involved in these operations and the general trends in the sector.

**Operational requirements of the research vessels.** Basic maritime precautions and procedures naturally apply to all seagoing research vessels. However, the scientific research element adds a unique dimension to shipboard operations seldom found in other areas of the maritime world.

The addition of the Science party to the ship and the unusual nature of the work to be performed make it necessary to integrate added safeguards and procedures not commonly found in other areas of maritime work. The operational aspects of the research program are potential trouble spots because of the non-standard nature or newness of the work. The participation of non-mariners conducting this work and the element of dual control by the Captain and Chief Scientist are also potential areas for problems. This chapter addresses the principal topics of general operations and some prudent steps to be taken to support the research program.

Recognizing that planned cruise tracks are often changed between the time a proposal is submitted and the time of the voyage, either the Master of all research vessels shall ensure that a cruise plan is on file with their home office, prior to sailing.

The actions required at the scene of a collision, accident, or casualty, and the follow-up paperwork, vary with the legal requirements.

Research vessels shall follow the all security requirements in force. Vessels and facilities required by these regulations shall submit and follow the provisions of a vessel or facility security plan.

Policies of a laboratory or institution operating research vessels regarding their safe operation should be clearly stated in written directives and posted or disseminated as appropriate.

Onboard of research vessels the interrelationship of the Master of a vessel and the Chief Scientist is unique. The ship's Master is, in both law and tradition, solely and ultimately responsible for the safety and good conduct of the ship and all persons embarked, including the scientific party. To avoid disputes and misunderstandings, the substance of these regulations and customs should be clearly set forth in the ship's Cruise Handbook or similar publication, since many scientists are not aware of the legal and customary constraints. Because of these legal responsibilities, the Master is also given full legal authority over all operations and personnel, both on board ship and in foreign ports. However, the primary objective of the Master and the crew is to facilitate carrying out the research in a safe and effective manner.

For the future design and concept of the research vessels, the fashionable "green ship" does not exist and the environmental impact free vessel is a theoretical concept. The term "greener" or "cleaner" ship is better wording. Reducing the environmental footprint of ships and their operations involves too many aspects for a straightforward meaning of the "green ship" concept. The continuous development of technologies and conventions gradually narrows the perception of "green." A flashy green ship today will likely be a pitch black one tomorrow.

**Operation of ships specialized for Polar waters.** Interest in the polar region is growing as the season for accessing these remote and hostile areas is lengthening. The nascent shipping ventures in these regions face new challenges and risks. Operating ships within any ice regime requires knowledge, skills and different awareness beyond that of many mariners. Multi-year and glacial ice are much

harder than the first-year ice which mariners may have experienced. There is little assistance available should things go wrong, so mariners must be self-sufficient.

Ships operating in the Arctic and Antarctic environments are exposed to a number of unique risks. Poor weather conditions and the relative lack of good charts, communication systems and other navigational aids pose challenges for mariners. The remoteness of the areas makes rescue or clean-up operations difficult and costly. Cold temperatures may reduce the effectiveness of numerous components of the ship, ranging from deck machinery and emergency equipment to sea suction.

The number of ice-classed vessels has dramatically increased in recent years because of the increased transport of oil from the eastern Baltic. Transportation routes from new northern oil and gas developments such as Sakhalin and Snovhit are mostly ice free but the harsh environment places operational challenges on the vessels and their crews. There is also the probability that new owners and operators without operational experience in these harsh conditions will enter the market in the future, imposing a need for guidance for these owners and operators as well as for shipyards building vessels for cold weather service.

Suitable materials for low temperatures are mandatory for proper functioning of the hull structure and equipment. Fresh water, ballast and fuel oil tanks should be carefully placed or fitted with heating equipment to avoid the chance of the tank's contents from freezing or leaking into the environment. The effects of cold air can have unintended effects on systems and machinery. Accordingly, the combustion air system is required to be routed directly to the prime movers to avoid exposing machinery and the crew to the ambient temperature. Operations in cold climates require additional equipment to receive weather reports, special radar to make contact with ice and lights suitable for the cold. Life boats should be enclosed and specially designed to operate in the cold.

Low temperatures require additional tasks to permit equipment to function or to conduct vessel operations. Owners/operators are responsible for operational guidelines and keeping these guidelines updated. The machinery on vessels operating in very low ambient temperatures (such as -30°C or less) may be subject to unusual operational events not occurring at higher temperatures. A failure mode effects analysis (FMEA) conducted early in the design evolution on various machinery and systems can help in identifying additional features or equipment/system design changes to prevent failures from occurring or to mitigate consequences, if failure occurs.

Vessels operating in low temperature environments are exposed to a number of unique conditions, most stemming in one way or another from the prevailing harsh weather conditions. These additional challenges make it imperative that additional crew training be undertaken and that comprehensive operations manuals are provided.

Safety and environmental standards for ships operating in cold climates and ice covered waters include international regulations, regional regulations as well as classification requirements. As it prepares for this new frontier, the industry is looking for broader guidance and is requesting more unified requirements governing the design and operation of ships for service in the Arctic. Additionally, concern for the environment can be expected to promote regulations that address emissions, contamination from water ballast and other ship-sourced pollution.

**Use of nuclear energy in marine propulsion.** Existing onboard energy storage and power generation systems predominantly develop power by breaking chemical bonds between atoms. In contrast, nuclear power generation is the fission of large, heavy nuclei into smaller fission products under controlled chain reactions.

To design and build nuclear-powered merchant ships significant changes to the normal design procedures are required. The process would be driven by a safety case in which the building, operation,

maintenance and decommissioning of the ship are the principal features. The safety case would embrace the nuclear, mechanical, electro-technical and naval architectural aspects of the ship design with the safety and integrity of the nuclear plant taking precedence. In any future merchant ship application of nuclear propulsion there would need to be cooperation between IMO and the IAEA to enable their different and extensive sets of expertise to be reflected in design regulation.

In addition to the requirements imposed on a nuclear-propelled ship, nuclear regulatory arrangements would be applied to the shore facilities used to support the shipboard reactor plants. These arrangements would need to be identified in the appropriate safety cases and levels of security similar to those currently applied to civil nuclear power plants are likely to act as a basis for the consideration. A key question relating to merchant ship nuclear powering applications is whether a nuclear plant is purchased or leased by the ship owner. This question embraces consideration of the cost of failures occurring in the system: a situation which has on occasions been extremely expensive to solve in some naval installations.

The key principles of nuclear liability are established by international treaties which influence national legislation and dictate the scope of operator liability. Countries are either signatories to the conventions or have legislation that adheres to the principles embodied within the conventions. As such, nuclear liability insurance policies must follow relevant national legislation and often require government approval. General non-nuclear risk insurance policies have radioactive contamination exclusions; these fulfil the channelling principle and nuclear insurance pools which insure the liabilities associated with nuclear facilities.

For the future, nuclear propulsion has clear greenhouse gas advantages and has been shown to be a practical proposition with naval ships and submarines as well in certain specialized ships and demonstrator projects.

**LNG gas fuelled ships.** The global shipping industry faces a challenge a-new legislation will significantly limit sulfur emissions from ships, firstly in North America and northern Europe in 2015. LNG is a potential solution for meeting these requirements - it has virtually no sulfur content, and its combustion produces low NO<sub>x</sub> compared to fuel oil and marine diesel oil. LNG is not only cleaner-burning, but may have economic advantages - on a calorific value basis even high Asian LNG prices are lower than global bunker fuel prices. As a result there have been recent developments to promote use of LNG as a bunker fuel.

LNG has been used to fuel diesel propulsion systems of LNG vessels since delivery of the *Provalys* in 2006. Today 48 existing LNG ships operate with dual fuel and tri-fuel diesel electric propulsion and another 85 LNG ships are on order. In view of the proven success of LNG as a fuel in marine diesel engines, ship owners have already constructed an estimated 30 LNG fuelled ships and have ordered more than 30 additional LNG fuelled ships. The two primary drivers that make LNG appear an attractive alternative to meet the Annex VI sulfur in fuel oil requirements are:

- 1. LNG allows ships to meet MARPOL Annex VI requirements for both worldwide trades and operation in ECAs as its sulfur content that is well below the Annex VI requirements for ECAs. Moreover, LNG reduces NO<sub>x</sub> emissions to levels that will meet MARPOL Annex VI without need for after treatment.*
- 2. In some markets, natural gas and LNG are lower priced than high sulfur marine fuel oils on a heating value basis.*

Sophisticated LNG engines and the cryogenic double-walled fuel tanks require significant capital investments, certainly when compared to oil fuelled ships. The observed cost range is partly linked to the ship design, the engine type (dual-fuel or single LNG engine), and the size of fuel tank (i.e.

dependent on the frequency of refilling) etc. Overall, the estimated cost for an LNG fuelled ship is between 20 to 25 percent higher compared to an oil equivalent vessel. In addition, it is noted that the cost for a newly built LNG fuelled vessel is less than the cost to convert a similar existing vessel. LNG is therefore more feasible for new ships. Nevertheless, LNG engine developments highlight the lower maintenance cost in comparison to oil engines due to a more clean and efficient system and a long lifetime of the machinery. Furthermore, the possible environmental cost (e.g. taxation or emission trading scheme) charged to shipping by governments will make the LNG cost savings more attractive than other options.

Regarding the infrastructure, almost all reviewed studies show a consensus that a critical challenge to the development of LNG as a ship fuel is the current lack of established bunkering infrastructure and distribution networks for delivering LNG to the ships. This significant barrier currently represents a ‘chicken-and-egg’ problem. Bunker suppliers are unwilling to invest in the infrastructure necessary until there is sufficient demand to supply commercial shipping with LNG fuel. On the other hand, ship owners are unwilling to invest in LNG-fuelled ships if supplies of LNG bunkers are difficult to obtain. In order to comply with the forthcoming ECA’s SOx limits in 2015 and NOx Tier III standard in 2016 (may have five-year delay to 2021); ship operators have three compliance strategies standing out as realistic options. Apart from switching to LNG, they can change to low sulphur fuel oil e.g. marine gas oil (MGO), or use scrubbers.

In addition to establishing guidelines for ship arrangements and system design, Resolution MSC.285(86) also provides operational and training requirements for seafarers for ships using gases or low-flashpoint fuels, which would be incorporated into future amendments to the Standards of Training, Certification and Watchkeeping (STCW) Convention and Code. In November 2013, the Correspondence Group submitted guidelines on developing training and certification requirements for seafarers on board ships subject to the international code of safety for ships using gases or low flashpoint fuels (IGF Code). The guidelines also recommend dividing training on gas-fueled ships into three categories (i.e., basic training for the basic safety crew, supplementary training for deck officers, and supplementary training for engineering officers).

**Operation of ships with revolutionary propulsion systems.** The propulsion of a vessel is affected by the propelling unit, which needs to be fed with energy. This energy can be gained from regenerative energies or fuels or a combination of both.

The disadvantage of all regenerative energies is the question of availability and storage, especially since ships are independent, mobile systems, which have to be available at any time for security reasons alone. Therefore the question arises whether it wouldn’t be more favorable to “exploit” the regenerative energies on a technically large scale in order to generate, by means of conversion, fuels of high energy density.

When talking about new materials in connection with power density, there is no getting around from a discovery which was made in 1911 – the superconductivity. Various companies especially in Germany, Japan, and the United States have advanced the development of generators and engines on the basis of the high-temperature superconductor HTS technology – to be mentioned here are the Siemens Company, Sumitomo Electric Industries, and American Superconductor.

Photovoltaic methods offer an approach for limited amounts of power generation on board ships and trials have demonstrated that some benefit is available for auxiliary power requirements. However, the maximum contribution is small when compared with the power required to drive the ship. There is design potential to adopt a range of rigid and flexible technologies. However, the principal constraint is the ability to find a large deck surface area on the ship which does not interfere with cargo handling

or other purposes for which the ship was designed. In this context car transporters are an obvious candidate for the application of this technology

Hydrogen is a potential alternative fuel for ship propulsion. It requires energy to produce hydrogen and this could come from either conventional fuels or non-fossil sources such as wind, hydro-electric or nuclear. Currently, all hydrogen used in industry is made from natural gas. In the case of conventional sources, in order to be effective in CO<sub>2</sub> reduction the issue of whether the greenhouse gas emissions are simply being transferred from a source on the sea to one on land has to be adequately resolved as carbon sequestration and storage has yet to be demonstrated at scale. In 2007 was assessed the application of liquid H<sub>2</sub> to a concept propulsion study of a high speed container vessel designed for high value, time-sensitive goods as an alternative to air freight. Liquid hydrogen benefits from a much higher specific heat per unit weight than conventional fuels but requires a much greater volume for storage.

Compressed air and liquid nitrogen are two further alternative sources of energy storage for ship propulsion. Both require energy to produce or compress in the cases of liquid nitrogen and air respectively. As with hydrogen the necessary energy requirement can be derived from conventional and non-fossil fuels or renewable sources together with the same caveats. Furthermore, being energy storage media they exhibit similar system behaviours to those of the more conventional battery or capacitor technologies.

For many years, electric propulsion plants employed alternating current distribution systems. Alternating current AC systems were long regarded as the best solution, and a large number of diesel-electric vessels with alternating current systems and variable speed drives were built, for diverse purposes. But times are changing, thanks to new direct current components and an innovative engine control philosophy Diesel-electric propulsion has evolved, creating a much more compact solution with a range of potential applications. EPROX is the new fuel-efficient diesel-electric propulsion system from MAN Diesel & Turbo, developed in partnership with leading e-suppliers. Efficient propulsion plants with integrated energy storage sources are now a reality due to advances in direct current distribution technology. This decouples some of the load applications on the propeller from the diesel engine, reducing peak loads, and making the entire propulsion plant more responsive and dynamic. When powered solely by electricity from storage sources, the system produces zero emissions.

Hybrid propulsion is an option where one or more modes of powering the ship can be utilized to optimize performance for economic, environmental or operational reasons. Most commonly today the different powering modes feed a common electrical bus bar from which power can be drawn for various purposes. This, however, need not necessarily be the case since many examples of mechanical linkages between independent power sources have been designed and operated in ships, both past and present.

**Skysail propulsion for ships.** SkySails – Shipping’s New Power Towing kite propulsion offers significant fuel savings and avoids climate damaging emissions Increasing fuel costs and stricter environmental regulations - these are problems shipping companies and ship owners are already confronted with today and will be increasingly in the future. The Hamburg-based company SkySails has developed a wind propulsion system which allows modern shipping to take advantage of wind energy, which is available offshore free-of-charge. The SkySails system is comprised of a fully-automatic towing kite propulsion and a wind-optimized routing system.

The SkySails system consists of the components towing kite, control system, launch and recovery system and a wind-optimised routing system. It operates fully automatically, thus no additional staff is

required on board. The towing kite generates propulsion power. Its double-wall aerofoil profile is similar to that of a paraglider. It is comprised entirely of high-strength, weatherproof textiles. The towing kite is operated fully automatically. For this, the autopilot - which is similar to that of an airplane and is installed at the bridge - sends commands to the control pod, which is situated below the towing kite. The control pod is connected to the towing kite via a line tree. Its function is similar to that of a paraglider pilot: it lengthens or shortens the control chords at the left or right and thereby modifies the flight path of the towing kite.

The SkySails system generates significantly higher propulsion power per square metre sail area than conventional sailing propulsions. This is because of the technical possibilities, which arise due to the spatial separation of the ship and the “sail” or towing kite. The tight flying SkySails systems can operate at altitudes of 100 to 300m, where considerably stronger and more stable winds prevail. At an altitude of 100 m the average wind speed is between 10 and 20% higher than at an altitude of 10 m, due to the absence of resistance from the surfaces of earth and water. A higher wind speed is particularly relevant, since for the calculation of the traction power of the SkySails towing kite the wind speed is squared. Thus, an increase in wind speed of 15% represents an increase of the traction power of the SkySails system of over 30%. A further significant technological advantage of the SkySails propulsion system is the fact that the towing kite can be navigated “dynamically”.

The SkySails propulsion includes a multi-level safety system ensuring the smooth operation of the system and protecting the system from potentially harmful outside influences. The safety system is based on the following principles: *Risk prevention*; *Risk limitation*; and, *Handling of emergency situations*.

**The use of sailing-conventional hybrid for ship propulsion.** Sails on masts include both traditional sails and wings, which are airfoil-like structures that are similar to airplane wings. In the late 1970s, the high oil price stimulated the interest in wind power for merchant vessels. Some interesting vessels were built or converted like the “Shin Aitoku Maru” tanker and the “Usuki Pioneer” bulk carrier. It was calculated an average fuel reduction of 30%-40% but due to the falling oil prices at that time, the projects were canceled. In Denmark, the “Windship” bulk carrier was designed with six masts with fixed sails. Energy savings of up to 27 % were estimated, but the system was never tested because there were many disadvantages. The cruise vessel “Eoseas” has been designed at the Yards STX. On its 305 meters of length there are six sails with a total surface of 12440m<sup>2</sup>. It is calculated that the new technologies applied in this vessel will allow reducing the 50% energetic consumptions. The designers estimate that the Eoseas would cost around 30% more than a conventional cruise vessel but its developers are confident that the investment will be amortized by the reduction of fuel consumption. This boat is still in a project stage.

Every child knows that mankind has sailed across the seven seas with 100% wind-powered ships for centuries. So it’s a no-brainer that a wind turbine maker developing their own cargo ship would want to utilize wind power as a means of propulsion somehow. The engineering challenge was to find a way to adapt the age-old concept of sailing to the requirements of 21st-century cargo shipping. In a nutshell: a modern sailing vessel has to be reliable, it can’t be manpower intensive, and it has to be superior in a meaningful way. To solve this problem, the Enercon engineers embraced the concept of “rotor-ships” developed by the German engineer and inventor Anton Flettner during the early 1920s. Flettner utilized the “Magnus effect” to design an unconventional concept of propulsion for a sailing ship. The “Magnus effect” is the phenomenon whereby a spinning object flying in a fluid creates a whirlpool of fluid around itself, and experiences a force perpendicular to the line of motion. In the



case of the rotor-ships, the spinning objects are huge metal cylinders and the “fluid” is the wind. The resulting force was utilized to produce propulsion for the ships.

For the use of structural wing, the CargoXpress project is currently investigating a promising concept of a patented container vessel with on-board loading equipment and very low fuel consumption, as well as a structural sail. It is in study the possibility of designing the cover of the hatches as a sail. Moreover, the cover/superstructure could also be the crane for loading and unloading the containers. According to the project, the catamaran type vessel, of medium to high speed, will be suitable to access small maritime or fluvial ports to freight cargo serve as a feeder to the larger maritime terminals. It will be 85m long approximately with a 1600 tons of displacement. It is estimated that a great amount of fuel could be saved by hoisting the superstructure as a sail.

**Fuel cell propulsion.** Rising fuel prices and impending environmental regulations have created a pressure for ships to operate more efficiently and in an environmentally friendly manner. Fuel cell power production is a technology that can eliminate NO<sub>x</sub>, SO<sub>x</sub> and particle (PM) emissions, and reduce CO<sub>2</sub> emissions compared with emissions from diesel engines. Fuel cells powered by low carbon fuels (e.g. natural gas) will have local and regional benefits as both emissions and noise are reduced. In the longer term, hydrogen fuel generated from renewables could lead to ships with zero carbon emissions.

The main advantages and challenges related to introducing fuel cell technology onto ships are:

*Advantages: Improved efficiency; Losses in the electrochemical conversion process generate heat that is recoverable; Reduced emissions to air CO<sub>2</sub> emissions lead to global warming; When hydrogen is used as fuel, no carbon compounds are emitted;*

*Challenges: New fuels; Investment costs; Lifetime; Operational costs; Life Cycle Assessments; Size*

Several fuel cell types exist, and their names reflect the materials used in the electrolyte. The properties of the electrolyte membrane affect the allowable operating temperatures and the nature of electrochemical reactions and fuel requirements. During the last decades several different fuel cell technologies have been proposed and developed, and their levels of maturity, realistic efficiency potential, and future prospects vary significantly.

Not only private owners becoming more aware of the potential benefits of marine based fuel cells, but so are local governments, private companies and the military. Unlike the pleasure craft industry, the commercial marine industry is slightly behind in terms of fuel cell applications, with only one area having an actual programme in place. This does not include the military which is very active in this area. The potential application areas that are already looking to employ fuel cell technology are: Water Taxi and Ferries, Cruise Ships and Research Vessels.

**Operational influence of the new design for ship hull (the high tech bow shapes).** There are several bow designs developed with the objective of reducing the added resistance in waves. In this thesis they are referred to as innovative bow designs, as they have features not found on most bow designs today with special consideration on added resistance in waves. The last decade some segments have opened up to unconventional bows, and some designs have become a relatively common feature in the fleet. This is probably most noticeable in the offshore service segments, where X-Bow from Ulstein Design and the STX OSV's relatively novel design has become the standard bow design on ships built at Ulstein Shipyard and STX' yards in Norway. Designs with these bows are also sold to yards and ship owners all over the world. In other segments and especially the larger segments of merchant ships the trend of highly innovative bow has not been the same. The offshore service fleet is

generally small compared to the merchant ships supplying the world trade. Still some designs have been developed especially for large segments, and at least one has been built and tested in full scale.

The objective of the X bow design is not merely to reduce added resistance in waves. It aims at improving several aspects of the operation of offshore vessels. Offshore service vessels often have the wheelhouse and superstructure in front of the mid ship. Thus motions are a critical point in this case for the accommodation and resting of the crew. Motion characteristics are also an important aspect of the operability of offshore vessels, which Ulstein Design claims to have improved with X bow. The patent application sums up advantages of X bow as (amongst others): *Lower accelerations and retardations, which give higher average speed at sea, thereby reducing power requirement and consumption of fuel; reduction in the amount of or elimination of green water on deck; lower risk of heavy weather damage to the foreship because the reflection of waves is reduced; improved working environment on board with regard to.*

The design is briefly described as a backward sloping bow above the water line. The underwater hull is similar to conventional hulls, thus the concept focus on the hull shape above the waterline.

An X-BOW vessel is characterised by its slender hull water line and a smoother volume distribution in the foreship. The many benefits of the X-BOW hull line design have been documented through tank tests performed by recognised maritime institutions and feedback from the owners and users of vessels with X-BOW.

STX OSV designs and builds offshore and specialized vessels used in the offshore oil and gas exploration and production and oil services industries. They have also developed an innovative bow concept, obviously focused on the segments mentioned above. On the same basis as for the X-bow, the bow is developed to improve performance in marine operations. The patent application states that the objective of the new bow is to reduce the added resistance in waves, as well as reducing the level of accelerations, motions in seaway and slamming in the bow region. This should result in less fuel consumption and more comfort for the crew.

The Ax-bow is a bow concept designed by NKK, the Japanese steel manufacturer and ship builder. The Ax-bow concept was developed because the energy saving measures in later years have led to a smaller power supply on merchant ships, thus the speed-loss of these energy-saving ships is crucial compared to ships with a large sea margin implemented. Hence, a ship with better performance in waves even with smaller installed propulsion power was desired. The bow concept was installed on “Kohyohsan”, a 172 000DWT Cape size bulk carrier with overall length of 289 m and breadth 45 m. A sister ship was fitted with an ordinary bow and full scale measurements have been done.

The Beak bow is a predecessor of the Ax-bow and is designed as a longer and pointy beak. Due to the mentioned length restrictions the Ax-bow was developed. The Beak bow tested by different researcher in the field, would give a ship with overall length of 300 m.

The Leadge bow is a further development of the Ax-bow. The working principles of the bow are the same as the Ax-bow, reflecting waves to the sides. However, the stem has been straightened filling up the gap between the “Ax” and the bulb. This eliminates the bulbous bow in the profile view. The whole stem line is sharpened, also under the waterline hull.

**The impact of green technology on ships operation capabilities.** Fuel will remain expensive beyond 2020 and will drive demand for energy efficient ships. These will focus on optimal energy use, and will be designed and operated with alternative fuels such as LNG, power systems, and light weight construction. The demand for renewable energy will have grown significantly and this in turn will create new markets for the maritime sector, including shipping of biofuels. In order to serve offshore power infrastructure development and operation, new specialized ships will be required.

There are numerous environmental issues emerging on the agenda that are set to become important after 2020. Those expected to be most significant from a regulatory perspective are black carbon, hull bio-fouling and underwater noise. Addressing SO<sub>x</sub>, NO<sub>x</sub>, ballast water and energy efficiency requirements more or less in the same timeframe requires a careful balancing act, where care must be taken so that the technology solution to one issue does not unduly constrain choices addressing the others.

In the context of innovation and adoption of new solutions, the green ship concept come with the following ideas: the low energy ship, the green fuelled ship, the electric ship, the digital ship, the Arctic ship and the virtual ship.

In a recent study of DNV, entitled “Shipping 2020”, have analysed almost 50,000 ships towards 2020 and reviewed the technology uptake. As the authors states, the main differences between scenarios taken in consideration are seen with respect to SO<sub>x</sub> reduction technologies, where fuel price and regulations play a major role. Scrubbers will be an important technology beginning in 2020, while LNG will have a steady uptake as we move towards 2020, depending on price. With respect to CO<sub>2</sub> and energy efficiency, the EEDI will be a major driver and we will start to see ships that are up to 30% more efficient than today’s average vessels.

**Special ships for offshore activities.** Offshore vessels are ships that specifically serve operational purposes such as oil exploration and construction work at the high seas. There are a variety of offshore vessels, which not only help in exploration and drilling of oil but also for providing necessary supplies to the excavation and construction units located at the high seas. Offshore ships also provide the transiting and relieving of crewing personnel to and from the high seas’ operational arenas, as and when necessitated.

As mentioned, above, the denotation of offshore vessels is a collective reference and as such includes a wide array of vessels employed in the high seas sector. They can be mainly classified into the following main groups: *Oil Exploration and Drilling Vessels, Offshore Support Vessels, Offshore Production Vessels, Construction/Special Purpose Vessels.*

Oil exploration vessels, as the name suggests, help in exploration and drilling of oil at high seas. The main types of exploration vessels are: *Drill ship, Jack Up Vessels, Offshore barge, Floating Platforms and Tenders.*

Certain offshore vessels provide the necessary manpower and technical reinforcement required so that the operational processes in the high seas continue smoothly and without any undesired interruptions. Such vessels are called as ‘offshore support vessels. Some of the main types of offshore support vessels are: *Anchor Handling Tug Vessel (AHTV), Seismic Vessel, Platform Supply Vessels (PSVs), Well Intervention Vessel, Accommodation Ships*

Offshore production vessels refer to those vessels that help in the production processes in the drilling units in the high seas. FPSOs (Floating, Production, Storage and Offloading) can be enumerated as an example of these types of offshore ships. Main types of these vessels are: *Floating Production Storage and Offloading (FPSO), Single Point Anchor Reservoir (SPAR) platform, Shuttle Tankers, Tension Leg Platform (TLP).*

Other offshore vessels’ of these type also include those that provide anchorage and tugging assistance and those kinds of ships that help in the positioning of deep sub-water cable and piping lines. Main types are: *Diving Support Vessel, Crane Vessel, Pipe Laying Vessel.*

**Drilling vessels.** One of the remarkable accomplishments of the petroleum industry has been the development of technology that allows for drilling wells offshore to access additional energy resources.

The basic offshore wellbore construction process is not significantly different than the rotary drilling process used for land based drilling. The main differences are the type drilling rig and modified methods used to carry out the operations in a more complex situation. For offshore drilling a mechanically stable offshore platform or floating vessel from which to drill must be provided. These range from permanent offshore fixed or floating platforms to temporary bottom-supported or floating drilling vessels.

Drilling vessels have always been at the forefront of the developments in the offshore industry, whether it concerns mono hull or semi-submersible vessels. And with operational conditions ranging from drilling to sailing, the optimisation of the performance of this type of vessels is a complex task. In the past drilling vessel were positioned at the field using a mooring system, but as a result of the ever increasing requirements for working water depth most drilling vessels are nowadays equipped with a DP system.

Drill ships are inherently ships designed to provide optimum viability while on water, thus making it easy for the conglomerates to engage their services for better qualitative results in the overall scheme of drilling viability and functionality.

**Installation vessels.** Rock has been used for ports and coastal protection purposes for centuries – for dikes and breakwaters, groins and scour protection. During the past several decades the major dredging contractors have become increasingly involved in the development and execution of rock installation vessels.

The most commonly used vessel is known as Side Stone Dumping Vessel (SSDV). Usually stone is loaded into compartments on the extremely strong, reinforced deck and the vessel sails to its destination, where dozer blades are used to push the rock over the side(s) of the vessel and deposit the stone accurately in the water with the aid of a positioning system.

Another Rock Installation vessel is known as a fall pipe vessel. Dynamically Positioned (Flexible) Fall Pipe Vessels (DP FFPV) are typically used in water depths exceeding 50 metres. They are either specially designed vessels or transformed bulk carriers which are intended to carry large amounts of rock in their holds. The loading capacities of these vessels vary greatly, from 1,200 tonnes to more than 33,500 tonnes.

Another type of installation vessel is represented by the cable laying vessel. Most cable repair ships could lay approximately 500 miles of cable when repairing a cable fault, whereas cable laying ships could lay up to 2,000 miles of new cable and also, if required, perform cable repairing functions on existing cables. From an operations point of view, it is necessary that cable laying ships carry a large number of special personnel, in addition to the crew, performing specialized activities: laying and repairing (joining) cables, testing cables and controlling the plough, far more than would be found on any normal general cargo ship. With respect to the general structure, the major difference relates to the large cable tank spaces which raise potential problems concerning not only racking strength, but also localised strength issues at the double bottom, and with respect to the vessel's global longitudinal strength. In general, a cable laying vessel would be subject to the normal cargo ship requirements of SOLAS, provided it was carrying not more than twelve passengers. The main concern from SOLAS would be the potential effects upon the vessel's stability from flooding of one of the large cable tanks, either as a result of impact damage or due to down flooding from the deck openings in heavy weather.

**Supply ships.** Supply vessels are a fairly new category of ships. The need for this type of vessel arose with the start of the oil exploration activity in the Gulf of Mexico in the mid 1950's. Since then, the use of supply vessels has been spread worldwide. The gradual exploration of more demanding areas

has contributed to an evolution of the supply vessels. Today the worldwide supply vessel fleet consists of more than 1000 vessels operating mainly in the Gulf of Mexico, the North Sea (approximately 15 per cent), West Africa, Asia-Pacific, the Middle East, Brazil and other miscellaneous locations in Latin America.

A supply vessel is a multi-task vessel and has to be designed for many different purposes. This is contrary to most other ships used worldwide, which commonly have one type of hold usually transporting one type of cargo. A consequence of being a multi-task vessel is that the determination of the best design with regard to economy of scale (in terms of size) and economy of scope (specialization) effects becomes more challenging. A supply vessel is a reliable means of transport. This is of course of great importance considering the significant shortage costs that can occur if the upstream logistics fails. According to literature and investigation, supply vessels rarely break down. Carrying capacity relates to the capability of a supply vessel to carry deck cargo and bulk cargo. Supplies transported on deck are classified as deck cargo and supplies transported in tanks underneath the deck are classified as bulk cargo.

Sailing capability relates to the ability of the vessel to sail under different conditions. Bad weather will make it necessary to decrease the speed to not jeopardize cargo and/or crew. High-speed travel in bad weather will make it difficult for the crew to get the needed rest; something that is of utmost importance for safe execution of offshore operations. Furthermore, too high a speed in bad weather could cause damage to the cargo.

Improvements and innovations that result in a higher speed without any major drawbacks are likely to be rapidly adopted by all ship designers. Today, all supply vessels used are designed to sail at approximately the same speed. However, it is tempting to explore the logistics consequences of having vessels that are significantly faster. It might seem obvious that the main advantage of having faster vessels is that a route can be carried out faster. In some situations we can imagine that this can lead to a reduction of the fleet by one vessel, something that would represent a significant financial saving. However, higher speed at sea usually comes with some major drawbacks that must be considered before we can conclude that faster vessels are beneficial and that savings are realizable.

**Marine diamond mining vessels.** Seabed mining can be subdivided into two components: shallow marine mining and deep sea mining. Shallow marine mining largely refers to the extraction of mud, sand and gravel for construction purposes and in some cases can also refer to the mining of valuable minerals in the near shore shallow waters.

Offshore diamond mining was originally carried out by divers operating small fishing boats at depths of up to 35 metres in coastal areas. By using 4" suction hoses, the divers sucked the loose sediment from the seabed and conveyed them upwards. Subsequently, all the material was transported to a stationary separation unit onshore where the diamonds were further away and graded. As larger diamond deposits were found farther from the coast, in water depths of up to 200 metres, it became necessary to develop special production systems for sustainable large-scale industrial diamond mining by various international mining and drilling suppliers. Finally, special air-lift vertical drilling system, mounted on a marine vessel prevailed as an economic and productive system. In areas where crawlers, dredging or comparable drilling systems had already operated, the application of this system increased the diamond production by up to 70 percent in the second mining campaign. Another advantage of the vertical mining systems is the universal applicability even on the roughest seabed surface where horizontal mining systems such as crawlers are unable to operate.

The mining vessel is positioned utilising four anchor lines in conjunction with a satellite positioning system. The drill bit is lowered using flanged pipes through a moon pool down to the seabed. The

drill-bit has a diameter of approximately seven metres and the flanged pipe has an inner diameter of 600 mm and is supplied in lengths of nine metres per section. The complete hydraulic drive unit for the drill pipe is installed in the drilling mast (approximately 35 m high) on the vessel and is suspended by two hydraulic cylinders with a stroke length of 12 metres.

**Pipelaying vessels.** Installation of pipelines and flowlines constitute some of the most challenging offshore operations. The technical challenges have spawned significant research and development efforts in a broad range of areas, not only in studies regarding different installation methods, but also in the formulation and implementation of new computational tools required to the numerical simulation.

The most common installation methods are the S-Lay, J-Lay, and Reel-Lay methods. In the S-Lay method, as the laying barge moves forward, the pipe is eased off the stern, curving downward through the water until it reaches the touchdown point.

**Deepwater mining vessels.** The development of equipment and techniques to investigate and exploit the deep seabed has been one of the great challenges to science and technology over the past half-century. As land-dwelling, air-breathing creatures, human beings have long struggled to conquer the vast, unfamiliar oceans.

Simon Stevin is a deepwater mining and fallpipe vessel that was delivered in early 2010. With a load capacity of 33,500t, she is considered to be the largest vessel of her kind in the world. She is also the first purpose built fallpipe vessel. Nordnes is the second largest fallpipe vessel. The vessel will be mainly utilised in the offshore market to install oil and gas pipes at large depths. The ship started off operations with two rock dumping projects in Australia. The basic design of the vessel was developed by Vuyk Engineering Rotterdam. The structural design was completed in cooperation with the builder CNN and the owner Jan De Nul. The hull was designed in close cooperation with Bureau Veritas (BV). The vessel has the capacity to carry 33,500t of quarry rock in two large rock hoppers located on the main deck that can hold 20t/m<sup>2</sup>. The two hydraulic excavator cranes discharge the rocks into the fall pipe module. Weighing 2,000t, the fall pipe module was built in Antwerp, Belgium.

**Seismic survey vessels.** The significant financial perils of drilling an unsuccessful well on dry land are only magnified when the unprofitable well is drilled in several thousand feet of water. Rig costs alone can top half a million dollars per day, with companies standing to lose a fortune should their expensive investments come up empty-handed. Fortunately, seismic surveys can save companies hundreds of millions of dollars by giving them precise information about subsurface features and even the presence of oil. Survey Vessels normally do one of the following tasks: *Hydrographic survey; Oceanographic research; Fisheries research; Naval research; Polar research; Oil exploration*. In essence, seismic surveys are a way to probe beneath the surface to “see” underlying features that make up the underground structure of a prospect. Such features can give companies a more astute indication if a prospect contains hydrocarbons.

Seismic vessels are ships that are solely used for the purpose of seismic survey in the high seas and oceans. A seismic vessel is used as a survey vessel for the purpose of pinpointing and locating the best possible area for oil drilling in the middle of the oceans. Companies engaged in the oil drilling process make use of such vessels so that they find the best possible subsea areas to drill oil. Another major reason such seismic vessels are so important is that if oil drillers do not get the best subsea location to drill the oil and gas, then it could lead to dangerous and threatening consequences for the marine ecosystem. The usage of the seismologic vessels prevents such inadvertent mistakes. For the purpose of

seismic survey, seismic waves are the main components that are analysed. The process involves a seismic detector that shoots such seismic waves to a selected underwater point. The time taken for the waves to refract back to their origin point determines whether that particular subsea area is feasible for the oil drilling purpose.

To meet the world's ever growing energy demand, the energy and petroleum industry is developing new technologies to find and drill for hydrocarbons in more challenging environments such as deep water or deep targets, and to enter areas of the world that had previously been closed to exploration activities, such as the Arctic. While the Arctic was looked at geologically several times in the last century, the technological challenges that it presents restricted activities to the periphery of this vast collection of basins. Despite the significant resource estimates, the extreme environmental conditions combined with the vast remoteness of this region have limited exploration and development efforts to date.

**Wind turbine installation vessels.** Implementing the ambitious targets of the offshore wind sector requires highly specialised ships capable of anchoring foundations to the sea floor and erecting huge turbine towers. In Europe, in particular, many offshore projects are planned for deeper waters further from the shore. This requires sailing speeds of up to 13 knots and jacking capabilities for water depths of up to 60 m. The Turbine Installation and maintenance support ships specifications are: *Ability to operate in 50 m of water; Self-propulsion; Ability to jack up the platform 10 to 15 m above sea level; Deck space to carry 900 to 1,000 t foundations; Ability to drive foundations piles into the seabed; Ability to transport a 90 m wind turbine tower; On-board crane to install the tower on its foundations and lift the nacelle (400 to 500 t) 110 m high; Deck space for preparatory work on large components; Accommodation for construction and ship crew; and, Dynamic positioning (DP) system.*

Det Norske Veritas specifications for a class of "Wind Turbine Installation Units" were published in October 2010 . Offshore installation company A2SEA announced the following specifications for "self propelled next generation jack-ups": *Self propelled; Speed: 10+ knots; Length: 100+ m; Breadth: 35+ m; Crane capacity: 800 to 1,000 t; Payload: 4,000+ t.*

Vessels are matched with projects based on economic and technical factors. Technical demands depend on the stage of installation. Requirements for foundation installation are different than for turbine and cable installation.

Having successfully completed the course, the student will be able to:



- ✓ Understand the designing particulars of the ships with special purpose
- ✓ Understand the operational requirements of different ships specialized for different maritime operations
- ✓ Investigate the seakeeping performance of these ships in all weather and all sea states
- ✓ Apply the safety measures in operation for each type of ship

## 4. Evaluation process of Master Course teaching materials

### 4.1 Evaluation model

For evaluation purpose the project team has chosen to use the questionnaire technique. For this reason there were created four types of questionnaire, one for each participant to evaluation process. The four types were created for the evaluation from students, lecturers, Administration and local shipping companies.

For students, Administration and shipping companies used questionnaires with multi-choice questions. These questionnaires will allow to the project team to synthesize the answers at the end of the evaluation process.


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**Student Course Evaluation Questionnaire**  
(To be filled by each Student at the time of Pilot Course Completion)


Course Title \_\_\_\_\_ Teacher Name: \_\_\_\_\_


Please give us your views so that Course quality can be improved. You are encouraged to be frank and constructive in your comments

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. The course objectives were clear	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I think I have made progress in this Course	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Fig.1. Example of Student Evaluation Form*





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**Administration Course Evaluation Questionnaire**

Evaluator Name: \_\_\_\_\_ Position: \_\_\_\_\_

1. Your company is part of
  - a) Port administration
  - b) Naval authority
  - c) Ministry of transportation
  - d) Other public institution
2. How do you get in contact with graduates from Naval Academies or Maritime Universities?
  - a) Direct contact
  - b) Reading reports
  - c) No contact at all
3. What do you think about their level of competence in safety issues?
  - a) Very poor
  - b) Poor
  - c) Good
  - d) Very good
4. What you think about their level of competence in security issues?
  - a) Very poor
  - b) Poor
  - c) Good
  - d) Very Good
5. What do you think level of competence they receive at undergraduate level?
  - a) It is sufficient for deck department
  - b) It is sufficient for engine department
  - c) It is not sufficient for deck department
  - d) It is not sufficient for engine department

**Fig.2. Example of Administration Evaluation Questionnaire**

For the lecturer evaluation, the project team members agreed to use questionnaire based on subject comments. The decision was taken considering that this kind of questionnaire offer to the lecturer the possibility to argue their opinions, helpfully during the analyzing of evaluation process. The meaning of this questionnaire is to show how the materials developed during the project are satisfying lecturer's expectations.



**Lecturer Course Evaluation Questionnaire**  
(To be filled by each teacher at the time of Pilot Course Completion)

Course Title:			
Total no. of Hours			
Name of Course Instructor:	Lectures		
	Seminars		
Assessment Methods:			

**Overview/Evaluation**

1) Curriculum: comment on the continuing appropriateness of the Course curriculum in relation to the intended learning outcomes (course objectives)

**Fig.3. Example of Lecturer Evaluation Form**

Have to be noted that the questionnaires can be modified or adjusted according to the feedback elements considered necessary during the Master program execution by any university that implement it.

#### **4.2 Selection of the evaluators**

For a proper evaluation process, the project team decided to nominate the evaluators according to the following criteria:

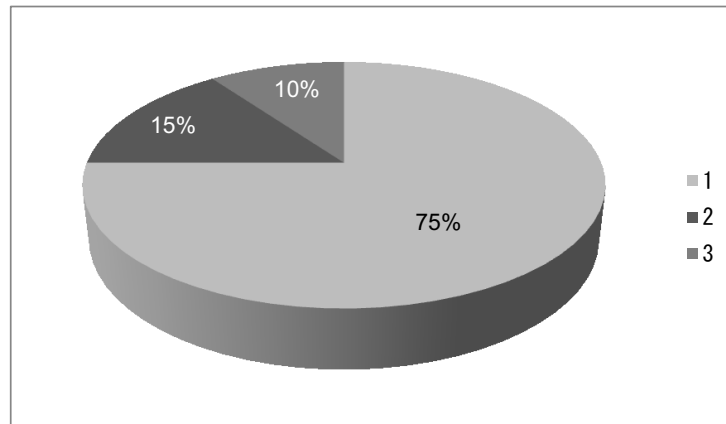
- a. *Students*: selected students have to be enrolled in a Master program and, preferable, to comply with the requirements for promotion to a management level position onboard ship. For a significant evaluation, it was decided to select minimum 20 students from each university.
- b. *Lecturers*: to have competence in the field of evaluated courses, preferable to have a management level certificate and not to be part of the project team. Based on these criteria it was made the nomination of two evaluators for each course in both universities.
- c. *Local shipping companies*: representative persons in charge with seafarers recruitment, training, onboard safety and security responsibilities and from top management positions. Were selected five companies from each participant country, companies involved in student recruitment process.
- d. *Administration*: for an optimum level of evaluation, the evaluator is required to be part of the management staff or from departments with duties on maritime safety.

### 4.3 Evaluation results

The evaluation results gave the opportunity to the project team to analyze the completion level of the project goals. In the same time, was useful to identify possible future corrections and subjects to be developed in the area of maritime safety training.

It has to be noted, that presented results included, also, the evaluation of courses developed during the IAMU FY 2012 Project “MAREM”, “Safety based ship design” and “Management of security threats”. The evaluation results are presented as satisfaction percents of different evaluators involved in the process. The presentation ways for evaluation results were chosen by the project team members considering as suggestive as possible for any interested person, for this reason was used graphics and labels.

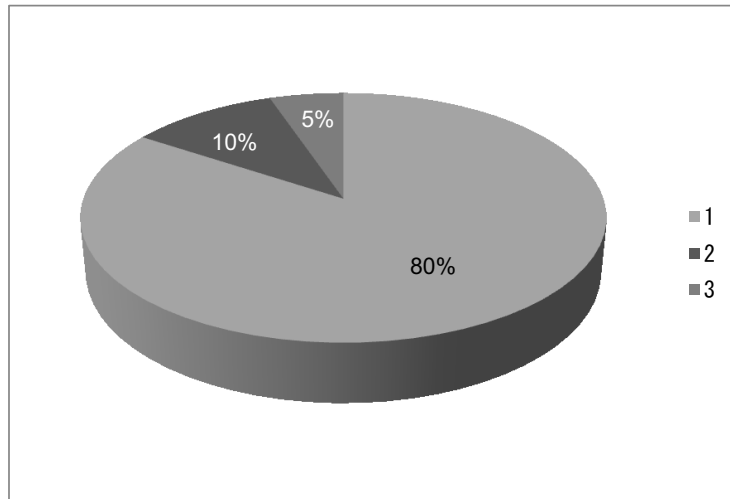
In Figure 4 are presented the results of Administration evaluation, with the explanatory legend below.



**Fig.4. Administrations evaluation results**

1. The Administration is fully satisfied by the content of the Courses and the way they are applied and used.
2. The Administration is satisfied by the content of the Courses.
3. The Administration is not satisfied by the content of the Courses.

Figure 5 shows the results of the local shipping companies evaluation questionnaire.



**Fig.5. Shipping companies evaluation results**

The legend of the figure result given by the representatives of the shipping companies is:

1. The Shipping Industry is fully satisfied by the content of the Courses and the way they are applied and used.
2. The Shipping Industry is satisfied by the content of the Courses.
3. The Shipping Industry is not satisfied by the content of the Courses.

For lecturer's evaluation, the results will be presented in each course, as final results of the evaluation made in both universities.

The following figures present the results of evaluation for Curriculum and Teaching materials for each course.

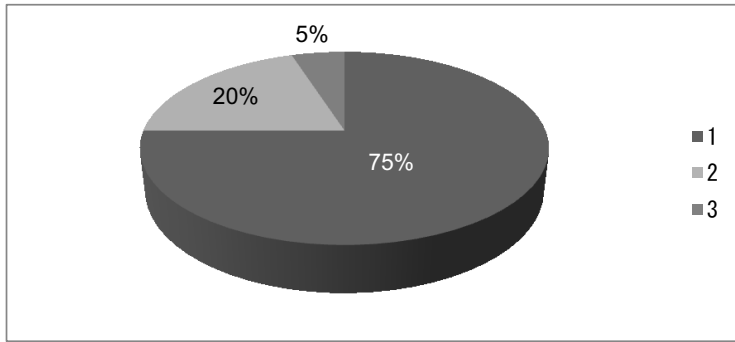
The explanatory legends for each evaluated subjects are:

a. *Curriculum:*

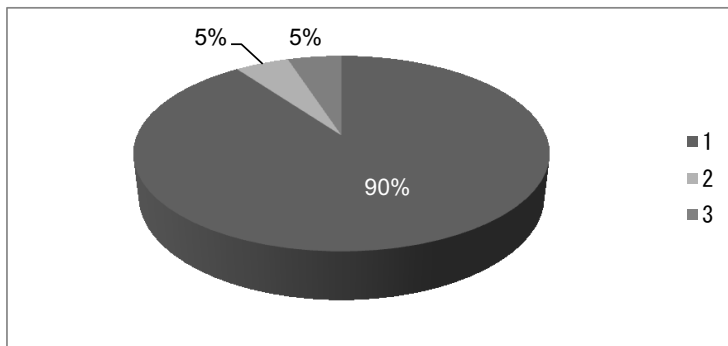
1. The course fully satisfies the announced goals. The successful fulfillment of the course will help achieving new and useful knowledge about the safety of the procedures. Very deep and founded view on the course problematic. Very useful according to the current challenges for the global maritime security.
2. The course satisfies the announced goals.
3. The course does not satisfy the announced goals.

b. *Teaching materials:*

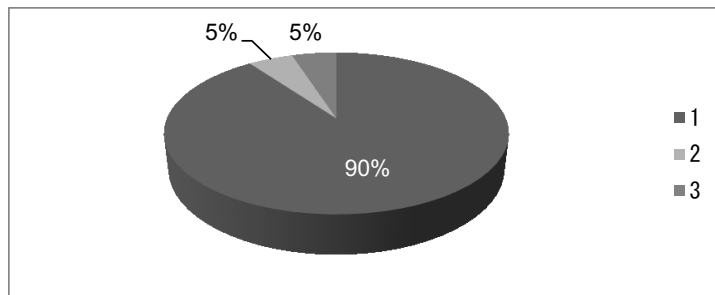
1. The teaching materials are enough, well-structured and developed. The teaching materials cover the topics and are easy available.
2. The teaching materials meet the needs and expectations.
3. The teaching materials are not enough and need improvement.



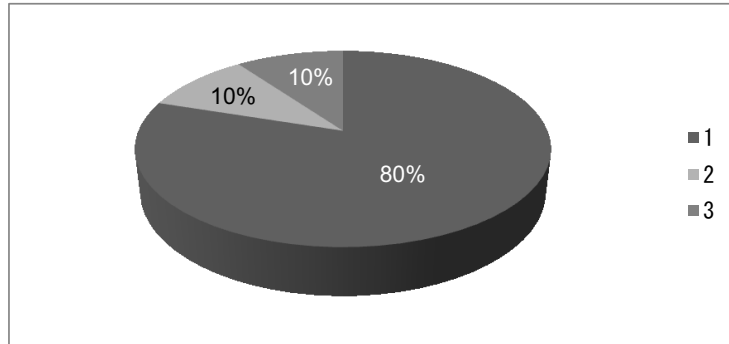
**Fig.6. Management of security threats - Curriculum: continuing appropriateness of the Course curriculum in relation to the intended learning outcomes (course objectives)**



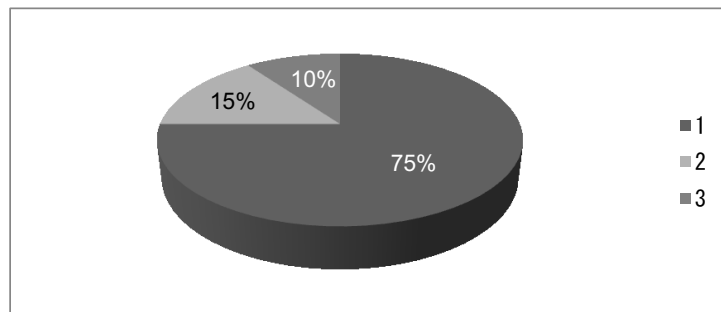
**Fig.7. Management of security threats - Teaching materials: effectiveness of teaching materials in relation to the intended learning outcomes (course objectives)**



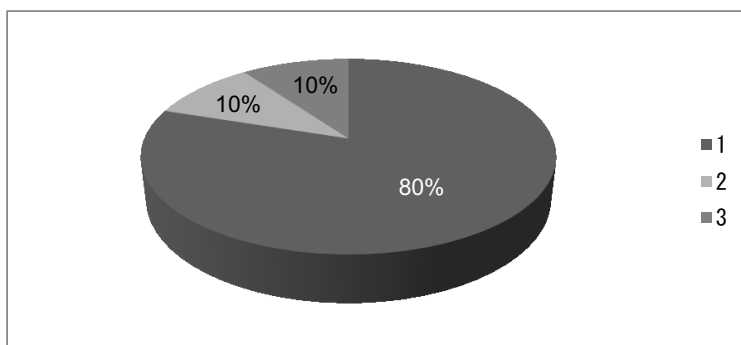
**Fig.8. Safety based ship design - Curriculum: continuing appropriateness of the Course curriculum in relation to the intended learning outcomes (course objectives)**



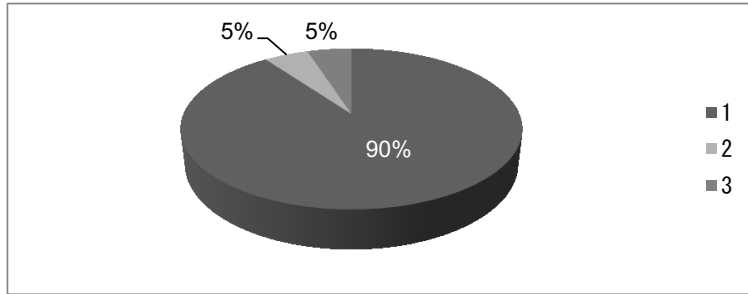
**Fig.9. Safety based ship design - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes  
 (course objectives)*



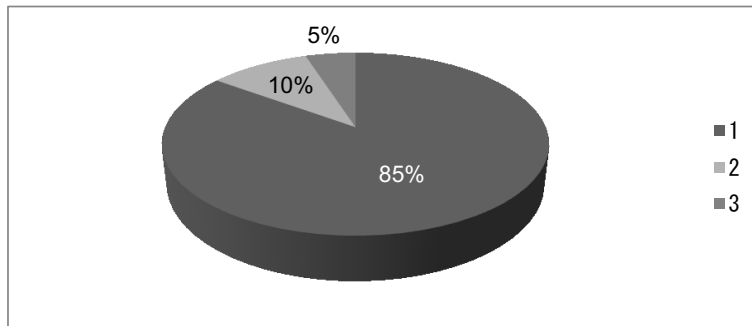
**Fig.10. Safety in maritime transport operations - Curriculum:**  
*continuing appropriateness of the Course curriculum in relation to the intended learning outcomes  
 (course objectives)*



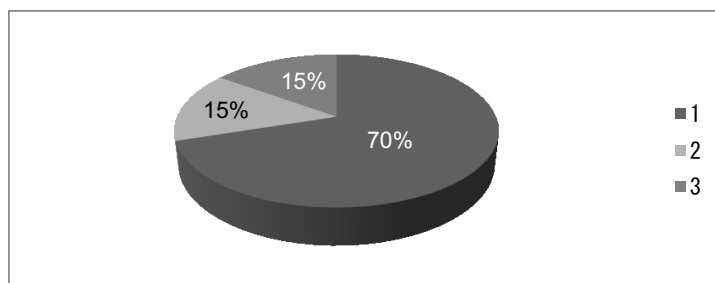
**Fig.11. Safety in maritime transport operations - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes  
 (course objectives)*



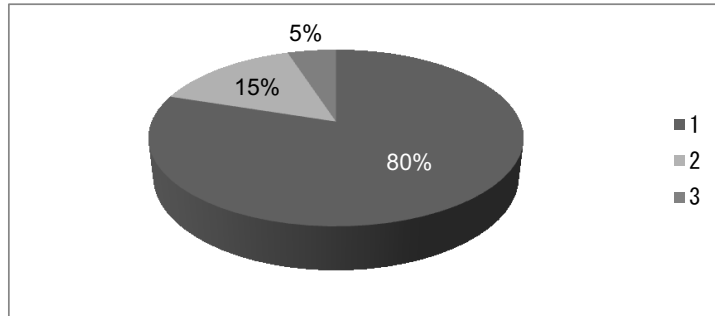
**Fig.12. Risk based safety - Curriculum:**  
*continuing appropriateness of the Course curriculum in relation to the intended learning outcomes  
 (course objectives)*



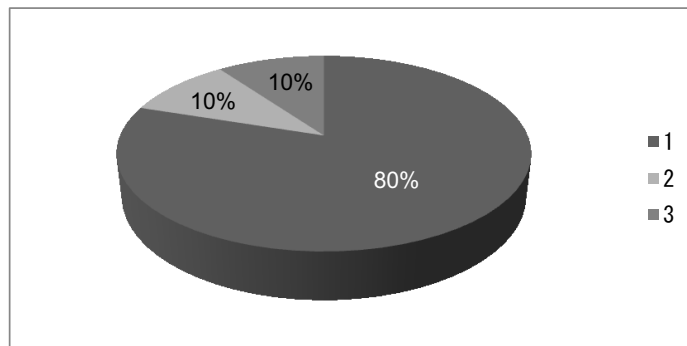
**Fig.13. Risk based safety - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes  
 (course objectives)*



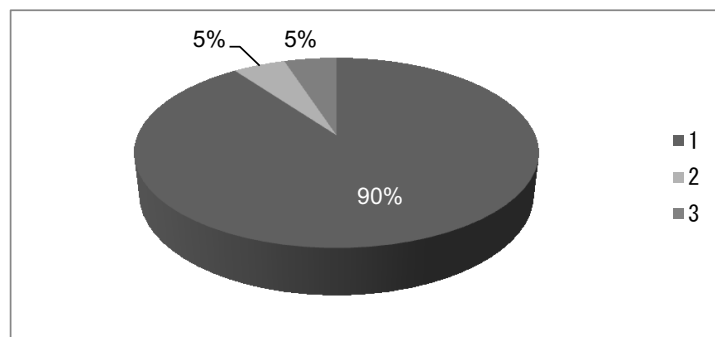
**Fig.14. Security awareness in piracy areas - Curriculum:**  
*continuing appropriateness of the Course curriculum in relation to the intended learning outcomes  
 (course objectives)*



**Fig.15. Security awareness in piracy areas - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes (course objectives)*

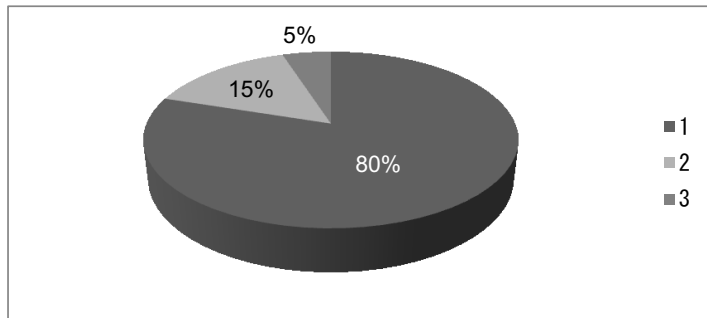


**Fig.16. Navigation safety - Curriculum:**  
*continuing appropriateness of the Course curriculum in relation to the intended learning outcomes (course objectives)*

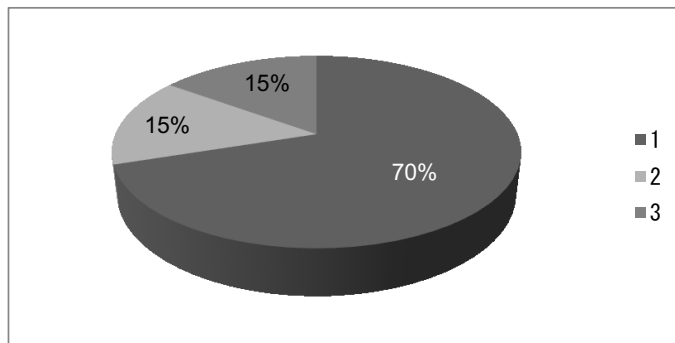


**Fig.17. Navigation safety - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes (course objectives)*





**Fig.18. Special ships operations - Curriculum:**  
*continuing appropriateness of the Course curriculum in relation to the intended learning outcomes  
 (course objectives)*



**Fig.19. Special ships operations - Teaching materials:**  
*effectiveness of teaching materials in relation to the intended learning outcomes  
 (course objectives)*

The final results of student evaluation for all courses are presented in the figures below.

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
1. The course objectives were clear	90%	10%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	75%	15%	10%	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	70%	10%	10%	10%	<input type="checkbox"/>
5. I think I have made progress in this Course	70%	10%	10%	10%	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	80%	<input type="checkbox"/>	20%	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	75%	5%	20%	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	80%	<input type="checkbox"/>	20%	<input type="checkbox"/>	<input type="checkbox"/>
9. Learning materials were relevant and useful.	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
10. Recommended reading Books etc. were relevant and appropriate	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
11. The Course stimulated my interest and thought on the subject area	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
12. The pace of the Course was appropriate	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
13. Ideas and concepts were presented clearly	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
14. The method of assessment were reasonable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
15. I understood the lectures	80%	5%	10%	5%	<input type="checkbox"/>
16. The material was well organized and presented	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
17. The instructor was responsive to student needs and problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
18. Had the instructor been regular throughout the course?	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
19. The material in the tutorials was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
20. I was happy with the amount of work needed for tutorials	70%	15%	5%	10%	<input type="checkbox"/>
21. The tutor dealt effectively with my problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
22. The material in the practicals was useful	95%	5%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. The demonstrators dealt effectively with my problems.	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>

**Fig.20. Student evaluation – Management of security threats**

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
1. The course objectives were clear	90%	10%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	80%	10%	5%	5%	<input type="checkbox"/>
5. I think I have made progress in this Course	75%	5%	15%	5%	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	80%	<input type="checkbox"/>	20%	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	75%	5%	20%	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	80%	<input type="checkbox"/>	20%	<input type="checkbox"/>	<input type="checkbox"/>
9. Learning materials were relevant and useful.	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
10. Recommended reading Books etc. were relevant and appropriate	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
11. The Course stimulated my interest and thought on the subject area	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
12. The pace of the Course was appropriate	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
13. Ideas and concepts were presented clearly	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
14. The method of assessment were reasonable	90%	<input type="checkbox"/>	10%	<input type="checkbox"/>	<input type="checkbox"/>
15. I understood the lectures	75%	5%	15%	5%	<input type="checkbox"/>
16. The material was well organized and presented	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
17. The instructor was responsive to student needs and problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
18. Had the instructor been regular throughout the course?	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
19. The material in the tutorials was useful	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
20. I was happy with the amount of work needed for tutorials	75%	5%	5%	15%	<input type="checkbox"/>
21. The tutor dealt effectively with my problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
22. The material in the practicals was useful	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
23. The demonstrators dealt effectively with my problems.	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>

**Fig.21. Student evaluation –Safety based ship design**

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
1. The course objectives were clear	95%	5%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	80%	10%	5%	<input type="checkbox"/>	5%
5. I think I have made progress in this Course	70%	15%	15%	<input type="checkbox"/>	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	70%	15%	15%	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	70%	15%	15%	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
9. Learning materials were relevant and useful.	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
10. Recommended reading Books etc. were relevant and appropriate	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
11. The Course stimulated my interest and thought on the subject area	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
12. The pace of the Course was appropriate	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
13. Ideas and concepts were presented clearly	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
14. The method of assessment were reasonable	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
15. I understood the lectures	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
16. The material was well organized and presented	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
17. The instructor was responsive to student needs and problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
18. Had the instructor been regular throughout the course?	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
19. The material in the tutorials was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
20. I was happy with the amount of work needed for tutorials	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
21. The tutor dealt effectively with my problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
22. The material in the practicals was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
23. The demonstrators dealt effectively with my problems.	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>

**Fig.22. Student evaluation –Safety in maritime transport operations**

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. The course objectives were clear	95%	5%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	90%	<input type="checkbox"/>	10%	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	90%	<input type="checkbox"/>	10%	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
5. I think I have made progress in this Course	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
9. Learning materials were relevant and useful.	75%	20%	5%	<input type="checkbox"/>	<input type="checkbox"/>
10. Recommended reading Books etc. were relevant and appropriate	75%	20%	5%	<input type="checkbox"/>	<input type="checkbox"/>
11. The Course stimulated my interest and thought on the subject area	75%	20%	5%	<input type="checkbox"/>	<input type="checkbox"/>
12. The pace of the Course was appropriate	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
13. Ideas and concepts were presented clearly	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
14. The method of assessment were reasonable	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
15. I understood the lectures	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
16. The material was well organized and presented	90%	10%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. The instructor was responsive to student needs and problems	90%	<input type="checkbox"/>	10%	<input type="checkbox"/>	<input type="checkbox"/>
18. Had the instructor been regular throughout the course?	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
19. The material in the tutorials was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
20. I was happy with the amount of work needed for tutorials	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
21. The tutor dealt effectively with my problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
22. The material in the practicals was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
23. The demonstrators dealt effectively with my problems.	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>

*Fig.23. Student evaluation –Risk based safety*

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
24. The course objectives were clear	90%	10%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. The Course workload was manageable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
26. The Course was well organized	90%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
27. I participated actively in the Course	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
28. I think I have made progress in this Course	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
29. I think the Course was well structured to achieve the learning outcomes	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
30. The learning and teaching methods encouraged participation.	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
31. The overall environment in the class was conducive to learning.	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
32. Learning materials were relevant and useful.	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
33. Recommended reading Books etc. were relevant and appropriate	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
34. The Course stimulated my interest and thought on the subject area	70%	20%	10%	<input type="checkbox"/>	<input type="checkbox"/>
35. The pace of the Course was appropriate	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
36. Ideas and concepts were presented clearly	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
37. The method of assessment were reasonable	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
38. I understood the lectures	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
39. The material was well organized and presented	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
40. The instructor was responsive to student needs and problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
41. Had the instructor been regular throughout the course?	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
42. The material in the tutorials was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
43. I was happy with the amount of work needed for tutorials	70%	20%	10%	<input type="checkbox"/>	<input type="checkbox"/>
44. The tutor dealt effectively with my problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
45. The material in the practicals was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
46. The demonstrators dealt effectively with my problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>

*Fig.24. Student evaluation –Safety awareness in piracy areas*

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
1. The course objectives were clear	80%	20%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The Course workload was manageable	70%	25%	5%	<input type="checkbox"/>	<input type="checkbox"/>
3. The Course was well organized	95%	2%	3%	<input type="checkbox"/>	<input type="checkbox"/>
4. I participated actively in the Course	75%	10%	10%	5%	<input type="checkbox"/>
5. I think I have made progress in this Course	70%	15%	10%	5%	<input type="checkbox"/>
6. I think the Course was well structured to achieve the learning outcomes	75%	20%	5%	<input type="checkbox"/>	<input type="checkbox"/>
7. The learning and teaching methods encouraged participation.	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
8. The overall environment in the class was conducive to learning.	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
9. Learning materials were relevant and useful.	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
10. Recommended reading Books etc. were relevant and appropriate	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
11. The Course stimulated my interest and thought on the subject area	75%	15%	10%	<input type="checkbox"/>	<input type="checkbox"/>
12. The pace of the Course was appropriate	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
13. Ideas and concepts were presented clearly	65%	20%	15%	<input type="checkbox"/>	<input type="checkbox"/>
14. The method of assessment were reasonable	70%	20%	10%	<input type="checkbox"/>	<input type="checkbox"/>
15. I understood the lectures	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
16. The material was well organized and presented	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
17. The instructor was responsive to student needs and problems	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
18. Had the instructor been regular throughout the course?	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
19. The material in the tutorials was useful	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
20. I was happy with the amount of work needed for tutorials	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
21. The tutor dealt effectively with my problems	80%	10%	10%	<input type="checkbox"/>	<input type="checkbox"/>
22. The material in the practicals was useful	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
23. The demonstrators dealt effectively with my problems.	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>

*Fig.25. Student evaluation – Navigation safety*

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Uncertain</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
47. The course objectives were clear	95%	5%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
48. The Course workload was manageable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
49. The Course was well organized	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
50. I participated actively in the Course	70%	10%	10%	10%	<input type="checkbox"/>
51. I think I have made progress in this Course	70%	5%	15%	10%	<input type="checkbox"/>
52. I think the Course was well structured to achieve the learning outcomes	70%	<input type="checkbox"/>	30%	<input type="checkbox"/>	<input type="checkbox"/>
53. The learning and teaching methods encouraged participation.	70%	5%	25%	<input type="checkbox"/>	<input type="checkbox"/>
54. The overall environment in the class was conducive to learning.	75%	<input type="checkbox"/>	25%	<input type="checkbox"/>	<input type="checkbox"/>
55. Learning materials were relevant and useful.	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
56. Recommended reading Books etc. were relevant and appropriate	85%	10%	5%	<input type="checkbox"/>	<input type="checkbox"/>
57. The Course stimulated my interest and thought on the subject area	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
58. The pace of the Course was appropriate	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
59. Ideas and concepts were presented clearly	80%	15%	5%	<input type="checkbox"/>	<input type="checkbox"/>
60. The method of assessment were reasonable	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
61. I understood the lectures	75%	5%	15%	5%	<input type="checkbox"/>
62. The material was well organized and presented	90%	5%	5%	<input type="checkbox"/>	<input type="checkbox"/>
63. The instructor was responsive to student needs and problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
64. Had the instructor been regular throughout the course?	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
65. The material in the tutorials was useful	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
66. I was happy with the amount of work needed for tutorials	75%	5%	5%	15%	<input type="checkbox"/>
67. The tutor dealt effectively with my problems	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
68. The material in the practicals was useful	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>
69. The demonstrators dealt effectively with my problems.	95%	<input type="checkbox"/>	5%	<input type="checkbox"/>	<input type="checkbox"/>

*Fig.26. Student evaluation – Special ships operations*



## 5. Acknowledgements

The project team wants to thank the International Association of Maritime Universities (IAMU) and The Nippon Foundation in Japan, for the support in obtaining the data and materials used in the present project.

## 6. Conclusions

Maritime safety is a complex area with many aspects, difficult to be defined and strictly nominated. Maritime safety means safety of the personnel, properties and environment. To study maritime safety and to understand the principle, is important to know and to have knowledge about the main components of this, like: construction and equipment of ships, crew training and their working conditions, transport of goods and passengers, safety of navigation activities and assistance in case of emergency situations.

Being a complex area of knowledge, maritime safety can be approached in many ways. Important is to respect the general goals and objectives of the field.

Starting from these considerations, the “MARSAS” project tried to cover all the interest subjects regarding maritime safety. During the project was developed teaching materials for treating subjects like: safety of navigation, safety of ship operations, safety and security in risky areas of navigation, risk assessment and measures to improve safety, special safety matters for special designed ships. The developed materials are intended to cover the enounced subjects and many other complementary to these.

“MARSAS” Project is developed to offer a different approach to the present matters regarding the safety of maritime transport activities. The approaching is made for a management level, considering that main decision in the line of ship safety and security are taken on this level. Also, being a master program, can be followed by trainees at operational level, in order to facilitate their promotion to management level.

To be sure that this consideration is reached, the project team realized an evaluation of the project idea and of the resulted materials. The evaluation was focused on participants interested in this kind of training, like academic staff, students and Administration and shipping industry representatives.

The evaluation results offered an image of the importance given to these subjects. The positive feedback of the evaluation

In the same time, consideration and comments of the evaluators are very useful for the future development of the program.

At the end of the Master program, graduates will be able to understand risks and threats for maritime safety and security and will be able to manage dangerous situations in order to conduct the ship in a safety manner.

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