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Abstract: The advantage of the latest technical development in the field of nautical sciences, automation, electronics, telecommunications, informatics, telematics, geomatics and global position fixing techniques, achievement in data storing, processing, analysing, transferring and visualisation should be taken into account and applied to the maritime technology. In the paper the author tries to discuss a strategic vision of development e-Navigation concept using those new technologies and the main tasks of the maritime community for the near future in international standardization of maritime education, training, scientific research and technological advances related to development of e-Navigation strategy in order to enhance the cooperation for maritime safety and security and protection of ocean environment. The author believes it is now appropriate time to develop a broad strategic vision for incorporating the use of new technologies in a structured way and ensuring that their use is compliant with the various electronic navigational and communication technologies and services that are already available. The author tries to present the background to „Why e-Navigation“ and its definition, the key elements which in the vision for e-Navigation were covered and the IMO's strength as the co-ordinator of e-Navigation development, including strategy implementation plan. The underlying important principles were stated, together with the need to take user needs into account. Later presentations and comments showed just how ambiguous the term „users” can be in the context of e-Navigation. This led to a more in depth review of the components of the IMO strategy implementation plan. The author tries to answer the question of whether these assumptions, decisions and actions taken were appropriate and sufficient. Implementing technology is like a three-legged stool: if any one leg is inadequate, the whole system fails. Here, one leg is the technology itself; another is the procedure for how to use the technology (gained through testing and experience) and the final one is maritime education and training, both in the operation of the technology itself but most importantly in using the technology with agreed, standardized procedures to make good decisions. The development of well-balanced and highly qualified seafarers is possible. It should be one of most important objectives for IAMU members.

Keywords: Navigation, Communications, Marine Transportation, Safety at Sea, Maritime Education and Training (MET), e-Navigation

1. Introduction. Development of e-Navigation Concept

The last decades have seen huge developments in technology within navigation and communication systems. Sophisticated and advanced technology is developing rapidly. Seafarers have never had more technological support systems than today and therefore there is a need to coordinate systems and more use of harmonized standards. Although ships now carry Global Satellite Navigation Systems (GNSS) and will soon all have reliable Electronic Chart Displays and Information Systems (ECDIS) [9], their use on board is not fully integrated and harmonized with other existing systems and those of other ships and ashore. At the same time it has been identified that the human element, including training, competency, language skills, workload and motivation are essential in today's world. Administrative burden, information overload and ergonomics are prominent concerns. A clear need has been identified for the application of good ergonomic principles in a well-structured human machine interface as part of the e-Navigation strategy [7],[10]. The combination of navigational errors and human failure indicate a potential failure of the larger system in which ships are navigated and controlled. Maritime accidents related to navigation continue to occur despite the development and availability of a number of ship- and shore-based technologies that promise to improve situational awareness and decision-making. These

The e-Navigation is a major IMO (International Maritime Organization) initiative to harmonise and enhance navigation systems and is expected to have a significant impact on the future of marine navigation. The IMO has mandated that this initiative be led by ‘user needs’. It is believed that these technologies can reduce navigational errors and failures, and deliver benefits in areas like search and rescue, pollution incident response, security and the protection of critical marine resources, such as fishing grounds. They may also contribute to efficiencies in the planning and operation of cargo logistics, by providing information about sea, port and forwarder conditions [8].

1.1 Definition of e-Navigation

e-Navigation is a current international initiative that is intended to facilitate the transition of maritime navigation into the digital era, is a vision for the integration of existing and new navigational tools, in a holistic and systematic manner that will enable the transmission, manipulation and display of navigational information in electronic format [12]. The IMO has defined e-Navigation as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment". e-Navigation would help reduce navigational accidents, errors and failures by developing standards for an accurate and cost effective shipping. e-Navigation is intended to meet present and future user needs through harmonisation of marine navigation systems and supporting shore services.

The IMO further describes the compelling need for e-Navigation as a clear and compelling need to equip the master of a vessel and those ashore responsible for the safety of shipping with modern, proven tools to make maritime navigation and communications more reliable and user friendly and thereby reducing errors. However, if current technological advances continue without proper coordination there is a risk that the future development of marine navigation systems will be hampered through a lack of standardisation onboard and ashore, incompatibility between vessels and an increased and unnecessary level of complexity.

1.2 Electronic Navigation versus e-Navigation

The strength of the IMO’s e-Navigation initiative is that it should lead to greater harmonization of navigation information and communication on an international basis. This will be essential for safety and international trade. The weakness, however, is the time it will take to obtain agreement by all nations and stakeholders, particularly in a time of such rapid technology advancement. Electronic navigation is with us now and is epitomized by ECDIS with GNSS. We recognize that this is widely relied upon, or even over-relied upon. The training requirements for ECDIS came into force in January 2012 as per the Manila amendment to STCW [4], and the first phase of ECDIS carriage requirements commenced in July 2012. The phased carriage requirement of Electronic Chart Display and Information System (ECDIS) is underway and is scheduled to be completed by 2018. ECDIS is a complex system and will be one of the most essential tools for supporting mariners in their efforts to ensure the safety of navigation and protection of the marine environment’. The ability to harness the power of ECDIS and to avoid catastrophe due to incompetence is largely down to training and familiarisation.

1.3 ECDIS Guidance for Good Practice

All Comprehensive guidance is available in the IMO Circular MSC.1/Circ.1503 ECDIS Guidance for Good Practice [6]. All ships masters, navigating officers and operators of ships fitted with ECDIS are encouraged to use this guidance to facilitate the safe and effective use of ECDIS.
Ship owners and operators need to ensure careful management and regular maintenance of both ECDIS hardware and software. MSC.1/Circ.1503 contains guidance on maintenance of ECDIS software and identifies the need to keep ECDIS updated to meet the current International Hydrographic Organization (IHO) standards.

A list of known ECDIS anomalies is included in MSC.1/Circ.1503. Due to the complex nature of ECDIS, and because it involves a mix of hardware, software and data, it is possible (but considered not likely) that further undetected anomalies may exist. The existence of anomalies highlights the importance of maintaining ECDIS software to ensure the correct display of up-to-date electronic navigational charts. To help understand the extent of these anomalies, navigating officers are encouraged to report any such anomalies, including specific details regarding fitted equipment, to their flag State authority.

The IHO has produced an ECDIS Data Presentation and Performance Check dataset that allows mariners to check some important aspects of the operation of their ECDIS. This dataset contains two fictitious ENC cells which can be loaded into an ECDIS to assess operating performance. The test will check whether there are any display anomalies that need to be remedied or otherwise managed. If the check highlights a problem, guidance notes in the check dataset offer suggested courses of action.

2. The IMO e-Navigation Strategy

It should be noted that the term e-Navigation is often used in a generic sense by equipment and service providers. This claim should be seen as an aspiration, rather than an indication of compliance. The e- Navigation is a concept to support and improve decision-making through maritime information management and it aims to [7]:
- facilitate the safe and secure navigation of vessels by improved traffic management, and through the promotion of better standards for safe navigation;
- improve the protection of the marine and coastal environment from pollution;
- enable higher efficiency and reduced costs in transport and logistics;
- improve contingency response, and search and rescue services;
- enhance management and usability of information onboard and ashore to support effective decision making, and to optimize the level of administrative workload for the mariner.

The e-Navigation aims to provide digital information for the benefit of maritime safety, security and protection of the environment, reducing the administrative burden and increasing the efficiency of maritime trade and transport. The work conducted by the IMO during the last years lead to the identification of specific user needs and potential e-Navigation solutions. The e-Navigation Strategy Implementation Plan (SIP), which was approved in 2014, contains a list of tasks required to be conducted in order to address 5 prioritized e-Navigation solutions, namely [10]:
- improved, harmonized and user-friendly bridge design;
- means for standardized and automated reporting;
- improved reliability, resilience and integrity of bridge equipment and navigation information;
- integration and presentation of available information in graphical displays received via communication equipment; and
- improved Communication of VTS Service Portfolio (not limited to VTS stations).

It is expected that these tasks, when completed during the period 2015–2020, should provide the industry with harmonized information in order to start designing products and services to meet the e-Navigation solutions. The ultimate goal of e-Navigation is to integrate ship borne and land based technology on a so far unseen level. e-Navigation is meant to integrate existing and new electronic navigational tools (ship and shore based) into one comprehensive system that will contribute to enhanced navigational safety and security while reducing the workload of the mariner (navigator) [3]. The bridge between those two domains will be broadband communication technology which is about to arrive in regular
commercial shipping within the next years to come. The constituting element of this integration, however, is a common maritime data model. The existing concept of the Geospatial Information Registry can be adapted to the enhanced scope of a future Marine Information Registry covering additional maritime domains by expansion, amendment and moderate rearrangement. Though the basic philosophy of the IHO S-100 Registry prevails, virtual barriers for maritime stakeholders to associate with the Registry concept must be lowered by all means. This includes options to adopt existing register-like structures including identifier systems and stewardship for selected areas and elements of additional maritime domains in contrast to the possibly daunting overall third party ownership for a wide scientific field by potential contributors. Besides the recognized international organizations like, IMO, IHO and IALA who are currently discussing the further steps in e-Navigation, a grass root movement may take place with several stakeholders involved populating the Marine Information Registry. Such a grass root movement would truly demonstrate that e-Navigation has been understood and accepted. To allow for the orderly development of that stage of e-Navigation in accordance with the IMO defined goals and aspirations of e-Navigation, it would be required to activate the appropriate IMO instruments already in place to define the fundamental principles and structure of the Marine Information Registry, to assign roles and responsibilities amongst international organizations and stakeholders, and thereby facilitate the seventh pillar of e-Navigation, its “cement”, namely the Common Maritime Data Structure (CDMS) [11].

For ships’ navigating officers, masters and pilots to make the very best decisions concerning the safe navigation of a vessel, they need quality tools, good procedures and training that addresses how to use such tools within the context of making good decisions. Users need to be competent and confident when using information from navigation equipment such as ECDIS, Radar, ARPA, AIS, and electronic position fixing systems, in order to use them as effective tools.

3. Maritime Education and Training

Extensive and detailed requirements of training and assessment for the ship-side users of navigational systems, the seafarers, are determined in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978 [4]. In 2010 the Manila amendments were adopted (STCW 2010). The members of IMO recognized e.g.:

“the need to allow for the timely amendment of such mandatory standards and provisions in order to effectively respond to changes in technology, operations, practices and procedures used on board ships”

and

“that a large percentage of maritime casualties and pollution incidents are caused by human error”.

Figure 1 Conceptual, e-Navigation Compliant Architecture Overview
Such changes generate new demands on training institutions and on instructors working within them. The implementation of the e-Navigation concept on board and ashore requires a further adaption related to new training concepts and new instructional media to changed standards. Complementary it must be ensured that instructors and assessors are appropriately trained and experienced. Trainers must be qualified in the task for which training is being conducted.

3.1. Training and Assessment On-line Introducing New Technology

During the last decades a lot of new navigational systems were installed on ships’ bridges. Responding to that development the Maritime Safety Committee (MSC) published already in June 2003 the MSC/Circ. 1091 “Issues to be considered when introducing new technology on board ship” [5]. The introduction describes the way of looking at the problem in summary:

“The effectiveness of crews to use the technology safely and to best effect requires familiarity with the equipment and training as recognized in the STCW Convention. There are a number of aspects to be considered with respect to how seafarers interact with the technology and also some issues to be considered when assessing the training needs for the seafarers who use such technology” [5].

Furthermore document [5] stipulates issues to consider for the training of seafarers when introducing new technology:

a) Standardization: Although performance standards exist, the controls and displays are not standardized. The result is an increase in the amount of training needed to make a seafarer familiar with and effective in the use of the equipment. There are some causes which make increased training impossible e.g. a seafarer joins the vessel just prior to departure or the system aboard the vessel is very different from those on which the seafarer has received training ashore.

“One solution is to familiarise seafarers with equipment by training them using simulators (either desktop or full mission) prior to them joining their ships. This is made far more efficient when manufacturer provide assistance in developing the training tools” [5].

This solution can be improved by developing a common interface with standard symbology for common operations. Seafarers should be trained to use the standard display whenever possible, preconditioned the “standard operation” includes all functionalities for safe navigation.

b) Training for technology based systems: There are a lot of challenges to be managed when training seafarers for using technology-based systems on board. E.g. different cultural and practical behaviour patterns. It was ascertained that many young watchkeepers have a culture of using in-formation technology (home computers, Internet, video games etc.) and that during times of stress revert to electronic displays for their primary decision support systems. “Inexperienced seafarer may seek more data and information in stressful situations, often confusing themselves further. Problems can also develop when novice navigators are trained on desktop simulators which do not have the advantage of a simulated ‘window’ for visual observation. This may reinforce the habit of constant reliance on a digital display for situational awareness during actual operations” [5]. One quintessence concluding this section is that only well-trained officers understand to manage and prioritise ECDIS and AIS information. The same information provided to an officer without ECDIS and AIS training can lead to information overload and poor decision making.

c) Introducing new technology regarding the human element: The results of research referenced to automation are:
- automation has qualitative consequences for human work and safety,
- automation does not simply replace human work with machine work,
- automation changes the task it was meant to support,
- automation creates new error pathways,
- automation shifts the consequences of error further into the future and may delay opportunities for error detection and recovery,
- when automation is installed operators will monitor less effectively,  
- automation creates new kinds of knowledge demands.

“Watchkeepers must have a working knowledge of the functions of the automation in different situations, and know how to co-ordinate their activities with the automated system’s activities. This manifests itself in situations whereby officers do not understand weakness or limitations of systems they rely on. Training in this respect will become more important, as systems become more integrated and sophisticated” [5].

d) Summary: New technology installed on board can improve the efficiency and effectiveness of watchkeeping and consequential improve the safety of operations. However, this technology brings with it the inherent training requirement needed to operate the new systems physically, and also the training need to use the system to make better decisions. The positive effects of new technology will increase with degree of standardization of designs.

3.2 E-Navigation Specific Training

The IMO’s Strategy Implementation Plan (SIP) describes the further development of e-Navigation and contains a plan for enhancing public awareness of e-Navigation. The SIP focuses on five prioritized solutions, as follows [10]:

S1: improved, harmonized and user-friendly design;
S2: means for standardized and automated reporting;
S3: improved reliability, resilience and integrity of bridge equipment and navigation information;
S4: integration and presentation of available information in graphical displays received via communications equipment; and
S9: improved communication of VTS Service Portfolio.

The implementation of all prioritized solutions require specific training referred to the used technical methods and new operational procedures to comply with the key messages for all stakeholders listed in the table “Examples of key messages to promote the benefits of e-Navigation”. A detailed description and a table presenting the structure of the SIP are included in [10]. Scrutinizing the solutions in detail it becomes clear that the solutions S1 and S4 address the equipment and its use on a ship only, while S2 and S9 address improved communications between ships, ship to shore and shore to ship. Solution S3 addresses both bridge equipment and e.g. shore-ship information as part of the PNT system. Consequently training courses which must developed for the solutions S2 and S9 must include new technical and operational competencies for both users groups, the seafarers and the shore side users. With regard to S9 the STCW requirements and the “IALA Model Course V-103/1 – Vessel Traffic Services Operator Training” must be revised. A possible solution could be an IMO Model Course: “Operational use of VTS Services” [1].

3.3 The Evolution of Using Simulators in Maritime Education and Training

By 1967 first ship simulators came into use for the maritime education of seafarers at merchant marine academies. In the 1990ies, along with the increasing capabilities of computers the simulators developed from pure radar simulators to full mission simulators with more and more sophisticated visualisation. The modern ship handling simulator provides the new students of the naval academies and universities with the opportunity to sample ship handling, without hazard. Simulators also allow working bridge personnel to learn the techniques of Bridge Team Management (BTM), working through a variety of potential problems that might never be encountered, but would be life-threatening should they occur.

The simulator allows mariners access to a real time simulation of the conditions aboard ship-on the bridge, in engineering spaces or in specialized spaces such as cargo handling at a lower cost than teaching classes aboard a training ship. Ship handling simulators are used to train mariners to handle
ships in a variety of situations, from docking and undocking, to navigating various approaches in a variety of conditions using actual ship performance data in real time. The key features to a ship simulator are real operational controls and a system that allows the instructors operating the simulator to put the simulator students into realistic situations. All simulators are designed to provide an experience as close as possible to the real world. Bridge simulators provide accurate visual representations through the "bridge windows" and some are even mounting on hydraulic platforms to mimic movement. The speed controls, steering, radar and charting systems are the same found on the bridge of modern ships.

Today marine simulators take over an increasing part in maritime training to raise safety standards. STCW 2010 [4], section A-I/12, contains the standards governing the use of simulators for maritime training of seafarer:
- Part 1 deals with the general performance standards for simulators used for mandatory simulator-based training, assessment of competence and in accordance with their specific type (Radar simulation, ARPA simulation);
- Part 2 deals with the training and assessment procedures. STCW 2010 [4] section B explains the “Recommended performance standards for non-mandatory types of simulation” “Such forms of simulation include, but are not limited to, the following types:
  1. navigation and watchkeeping;
  2. ship handling and manoeuvring;
  3. cargo handling and stowage;
  4. reporting and radiocommunications; and
  5. main and auxiliary machinery operation.

“Navigation and watchkeeping simulation equipment should, in addition to meeting all applicable performance standards set out in section A-I/12, be capable to .4 realistic simulate VTS communication procedures between ship and shore”.

For the shore side part of VTS communication the IALA Model course V, Part D – Guidelines for instructors, section 5, describes subjects and assessment criteria included in 100 hours simulated exercises.

3.4. E-Navigation Training Proposals

In this section the author presents the candidate solutions relating to education, training and using simulators. In the Interreg North Sea Region Programme ACCSEAS were identified in total 14 training proposals, described in the “Baseline Report” [1]. Some were portrayed in detail including technical specifications and user manuals. At the end of ACCSEAS project the solutions reached a different stage of development. For further work on training and use of simulators in e-Navigation training and demonstration it is reasonable to group them as follows:
1. Maritime Service Portfolios (MSPs),
2. Route Topology Model (RTM),
3. “Maritime Cloud” as an underlying technical framework solution,
4. Innovative Architecture for Ship Positioning:
   a) Multi Source Positioning Service,
   b) R-Mode at existing MF DGNSS and AIS Services,
5. Maritime Safety Information / Notices to Mariners (MSI/NM) Service,
6. No-Go-Area Service,
7. Tactical Route Suggestion Service (shore-ship),
8. Tactical Exchange of Intended Route (ship-ship and ship-shore),
9. Vessel Operations Coordination Tool (VOCT),
10. Dynamic Predictor (for tug boat operations),
11. Augmented Reality / Head-Up-Displays (HUDs),
12. Automated FAL Reporting,
13. Harmonized Data Exchange – Employing the Inter-VTS Exchange Format (IVEF),
14. Real Time Vessel Traffic Pattern Analysis and Warning Functionality for VTS.
The majority of mentioned solutions are thoroughly investigated and ready for developing training arrangements except the last three solutions. They are in principle recognized, but unfortunately yet not ready for developing training arrangements.

In addition, in the author opinion, we should take into account the following extra proposals:

1. Virtual Aids to Navigation (Virtual ATON) and AIS ATON (Real, Synthetic and Virtual),
2. Back-up Arrangements for ECDIS,
3. A robust electronic position-fixing system with redundancy,
4. IHO S-100 Universal Hydrographic Data Model (explanation and use).

First of all we should teach our students how to:
- avoid common-mode failures (e.g. GNSS, e-Loran, inertial systems, integrity checks),
- improve situational awareness (target matching, coherent presentation), and
- prevent information overload (alarm management, essential information only).

3.5. Training Requirements for Operating an e-Navigation ship

We must ask ourselves why we need this new concept and why we expect it to improve. From a simple look on the ships bridges we can see that the deck officer has a multitude of information presented to him at the same time on different displays (ECDIS, Radar, and GPS receiver) and the most important issue of all is that each equipment has functions/features that will distinguish itself from others that are to be found on different ships. Unfortunately, the user interface (the main menu) is not internationally standardized. Even if the information is readily available at almost any console (for example, position information provided by GPS, can be found at the radar and ECDIS displays) and operation at first glance seems simple and easy, in emergency situation, where will be required our fast response and quick decision to be made, even knowing where on the screen is presented the required information, the situation as a whole becomes very problematic [2],[7]. That means that each officer will need some time to find out how to operate the systems efficiently at the same time: there is the risk of accidents or misinterpretation of data due to fatigue or tiredness that is not all that uncommon in this line of activity. With e-Navigation we see an important step being made towards standardization while leaving with regard that sufficient room is left to equipment producers while leaving sufficient room for improvement. It is also under debate whether an S-Mode (Standard Mode) should be introduced for each equipment to be found on board a standard mode to which every officer and pilot should be familiarized, so to prevent any misinterpretation of data [7].

We must remember that e-Navigating means that the OOW has a completely autonomous and fully working system on board for a safe voyage, but also has the possibility to be fed with a wide variety of information from shore-based facilities [3]. That means e-Navigation requires a highly efficient data communication network that allows a constant flux of information between the ship and shore systems like VTS, ship to ship communication. This higher efficiency is needed because services like the VTS find themselves having to cope with a greater and greater number of ships and, as a result an increasing amount of time has to be spent on organizing the traffic flow and on security operations. Also the ships owners and charters will benefit because of improved communication with the ship allowing them to be up to date with her general operation. But the e-Navigation concept is not limited to the equipment on board a ship it also includes the officer as an integral part of the system, because based on all the information available to him, he is expected to make decisions that could make the difference between safe navigation and maritime disasters. But we must realize that every equipment has its limitations and its inherent flaws, and could fail to perform. Thus, it is a very dangerous trend that in modern days an OOW should rely only on the information provided by the GPS or RADAR or the ECDIS. Indeed, many masters consider for a good reason that on board their ships the most important equipment are the eyes, ears, and the mind of the OOW, and that the most important consoles are the windows of the ships [2].

Colreg states under Rule 5 that "a good every vessel shall at all time maintain a proper look out by sight and hearing as well as by all available means appropriate in prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision", and under Rule number 7 it
is stated: "every vessel shall use all available means appropriate to prevailing circumstances to determine if risk of collision exists" also it warns that "assumptions shall not be made on the basis of scanty information, especially scanty radar information". With this in mind we must realize that with the technological advancement in navigation equipment we expect the naval officers to exercise their profession in a safer manner. And indeed it should be so, but nowadays most of the naval accidents and naval disasters are due to human error [2]. However, along with the STCW convention, e-Navigation should make a great impact on safety levels and prevention of pollution. We think that it will be compulsory that upon arrival on a new ship (which has an integrated bridge system), the OOW must have special time allocated to reading the user manuals for the IBS equipment [2]. After that, a discussion and practical explanation session must be arranged under the supervision of senior officers, before the ship will leave the port.

3.6. Preparing Students for e-Navigation

At the Faculty of Navigation in Gdynia Maritime University, as in many other maritime universities [2], we are educating our students with due regard to e-Navigation concept since a few years. We believe that the maritime officer is a crucial part of this concept and the way they are educated is crucial to their future performances. In their two first years they learn how to navigate a ship without the use of modern systems. Disciplines like celestial navigation and coastal navigation emphasize the fact that a ship can be safely navigated with only a sextant, a compass, navigational charts, and a very well prepared bridge team of officers. They gain basic knowledge on theoretical and practical aspects of navigation as a whole. The program curricula includes Radar Navigation, Radar Plotting, as well as the use of ARPA. At these practical trainings our students are introduced to at least five/six different radar/ARPA display types, five/six various ECDIS simulators, five/six diverse GPS receivers, off course of different manufacturers. They learn how to make proper use of the ENCs, the GPS, AIS, ARPA, ECDIS, and the communication services on board a ship. The most important aspect of education regarding e-Navigation is represented by the skills they gain by working on simulator and how to use all the knowledge they have accumulated over the years and to experience situations that they may encounter at sea [2]. Apart from putting to practice the Colreg rules, they are accustomed to being in constant communication with VTS stations, as well as with ships in their vicinity.

4. Conclusions

The IMO as a specialized agency of the United Nations, which primary purpose is to develop and maintain a comprehensive regulatory framework for shipping and its remit includes safety, environmental concerns, legal matters, technical co-operation, maritime security and the efficiency of shipping and as the leading international body for maritime professionals will continue to use the resources of its members states to promote the effective application of the e-Navigation concept, of course including innovative methods of education and training. The maritime universities associated in the IAMU should assist in that process and therefore it is my pleasure to invite all maritime professionals to join in this critical effort.

Thanks to advances in information technology, free communication between ocean and land is now available and all maritime society carry forward the e-Navigation for maritime accident prevention, transport efficiency, energy conservation and marine environment protection purpose. A large-scale implementation of the e-Navigation features is inevitable in the near future. The impact of electronics and computers on the ships' bridges is well known for at least 20 years. Despite this, there are still a lot of debates regarding the real improvement of safety based on electronics. Because the future means e-Navigation, we have to start to prepare our students and cadets to face the challenges raised by an increasing amount of navigation information that must be selected, absorbed, processed and analysed in a proper way, in order to determine the correct actions.

In order to achieve this goal, to traditional methods to teach navigation must be added a new kind of module able to integrate the main information from all kind of navigational sources and sensors. We
have to develop the students’ habits to generate their own overall image of the surrounding situation, based on as much information available as possible. We also have to develop new kinds of maritime safety culture for our students for a self-learning process when confronted with new types of navigational equipment and a new layout/configuration of the integrated bridge system. They have to obtain a proper onboard training, starting with enough time to familiarize and understand the user manuals of the navigation equipment installed in the INS/IBS.

The e-Navigation is a broad concept that is aimed at enhancing navigation safety, security and the protection of the marine environment through the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means. It is envisioned that e-Navigation will be a ‘living’ concept that will evolve and adapt over a long time scale to support this objective. During this time information will change, technologies will change, political and commercial objectives will change, and tasks will change, and even our expectations will change. However it is unlikely that the need for safe and efficient seaborne transport will change significantly. It is also certain that the safe and efficient transport will continue to rely on good decisions being made on an increasingly constant and reliable basis. Some decisions may be made with increased dependence on technology, but at some level we will always rely on good human decisions being made and therefore every effort needs to be made to apply an understanding of the Human Element at all stages, of design, development, implementation and operation of e-Navigation. Therefore we need new, modified education and training system dedicated and targeted to e-Navigation and well standardised international procedures for marine navigation.

5. References