

E-navigation requires new methods of training for deck officers

Eugen Barsan, Codrut Muntean

Constantza Maritime University

Constantza, Romania

Abstract

Technological developments require IMO to take actions in order to draw definitions, standards and guidelines for the emerging term of “e-Navigation”. In accordance with IALA definition, e-Navigation integration and presentation of maritime information on board by electronic means must increase safety and security at sea and protect the marine environment. The key element in all this process is, again, the human factor and the level of training of the maritime officers.

In our paper we stress the new challenges that the deck officers face when they have to change the ship and became familiar with a totally different electronic equipment operation system. Only 3 to 4 years ago, two or three consecutive watches were enough for the deck officer to be accustomed with the use of ARPA, GPS, bridge consoles configuration and display of the main types of nautical and maneuvering information. Today, we think that the procedures that must be applied on a sophisticated electronic ship, upon the arrival of a new deck officer, must be revised and well-balanced from the point of view of duration and briefing topics.

We underlined the “upgrades” that must be made to the maritime academic curricula in order to develop new competencies for the deck officers in order to help them less stressfully absorb the technological pressure. In this context, a new course called “Integration of Nautical Information” was developed, with 75% of the time allotted to practical application on the full mission ship handling simulator in order to accommodate students with the use of integrated bridges and simultaneous reception of a great amount of nautical information.

In order to efficiently and safely use the high volume of digital and graphical information produced and displayed by these new types of bridge equipment, the OOW has to be properly trained in school and not only by on board practical means.

1 Introduction

Navigating the seas as a mean for transporting goods, livestock, and people has always been an important aspect of human civilization. Indeed, empires were forged and flourished due to commerce because there is no real substitute

to cargo transportation by water, due to its low cost and the high volume of cargo that can be shipped this way. Nowadays, in many parts of the world, we can't even imagine life without this important mean of trade that links continents and countries economically and politically.

An example for this reality are the ships themselves: in modern days, they are being assembled in a port, but their engines may come from a different country, their electronic equipment itself might originate from a country different from the previous two, and the owner may be from a different part of the world; not to mention that the crews that will be manning the ships could be international ones.

An interesting question that we could ask our selves is: what changes have the ships that have shaped our society as a whole, undergone (Wadsworth B., 2005)? The answer would be a very complex one. Since the Second World War, ships have begun to have an ever more important place in global economy: new concepts like Multi Modal Transport and the specialization of ships further asserted their importance. Their efficiency improved as new and powerful engines were developed and used which allowed greater speeds to be achieved, as well as new management ideas to be put into effect, such as ISM.

In the last fifteen years a fundamental change in the global economy, including the shipping industry, was dictated by the extensive use of computers. Today the computer is part of every day life for almost each of us; we find it in our homes, at our desks, and in our cars because it greatly increases our working efficiency and greatly improves the communication between two distant persons. The use of the computer is a fundamental change to our society, and it has already changed navigation, as it was perceived only 25 years ago.

This paper is about how the training of the deck maritime officer will be affected by this new concept that is emerging: "E-Navigation".

2 IMO-IALA policy for implementing E-Navigation

If we try to define E-Navigation beginning from the acronym itself, we will realize that we will not achieve an exhaustive definition, because the letter "e" stands not only for "Electronic" or "Enhanced" Navigation, it is only the name of a concept that includes those expressions written above.

In an effort to have a comprehensive definition, the International Association of Marine Aids to Navigation Lighthouse Association (IALA) proposed the following definition, in 2006:

"E-Navigation is the harmonized collection, integration, exchange, presentation and analysis of maritime 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". In other words, this concept includes the equipment used for navigational purposes and for communication, the entire electronic equipment that is to be found on the bridge of a ship and on shore, and this includes the technology that is already

available and the future one (IALA, 2008). We must also understand that if aboard a ship only part of the equipment stated above is to be found, that ship is not “e-navigating” (IMO, 2005), simply because it is necessary that the entire range of data should be available to the officer of the watch (OOW).

IALA committee has agreed that E –Navigation should have the following notable outcomes (IALA, 2008):

- a. “On board navigation systems will be developed that benefit from integration of own ship sensors, supporting information, a standard user interface, and a comprehensive system for managing guard zones and alerts. Core element of such a system will include high integrity electronic positioning, electronic navigational charts(ENC) and system functionality with analysis reducing human error, actively engaging the mariner in the process of navigation while preventing distraction and overburdening
- b. The management of vessel traffic and related services from ashore will be enhanced through better provision, coordination, and exchange of comprehensive data in formats that will be more easily understood and utilized by shore-based operators in support of vessel safety and efficiency
- c. E-Navigation will thus provide an infrastructure designed to enable authorized seamless information transfer on board ships, between ships, between ship and shore and between shore authorities and other parties with many attendant benefits, including a reduction of single person error.”

Furthermore, IALA states that the key goals for this concept should be:

- To improve the safety of maritime navigation for all vessels and protection of the environment.
- To improve the efficiency of marine navigation and vessel traffic services.
- To provide opportunities for improving the efficiency of transport and logistics.
- To improve the monitoring of communication with sea-borne transport therefore enabling competent authorities to provide enhanced security and other allied services.
- To support SAR services and incident management.
- To provide improved tools to facilitate optimum support and to engage mariners and shore based users whilst maintaining high levels of attention without causing distraction or undue burden.

3 On board E-navigation users’ interface

It has been stated that the equipment provides information to the maritime officer: what exactly is this equipment?

We can start with the electronic positioning-fixing system. This includes (but is not limited to) the GPS, DGPS, or the still working LORAN-C that are

crucial for the safety of navigation and for reducing the risk of accidents. This equipment is so important on board ships that most ships usually work with two or more in parallel: should one fail to perform, there will always be a spare. With regard to inshore navigation it has been observed that the GPS does not have the necessary accuracy to provide reliable information, and so the need for a position fixing system with redundancy lead to the development of systems like the European GALILEO satellite and radio navigation system and the People's Republic of China's COMPASS.

The next equipment is the ECN (Electronic Navigational Chart), or ECDIS (Electronic Chart). This equipment actually summarizes the data from all the equipment on the bridge, and from other services such as Vessel Traffic Management and Information Service (VTMIS). It gives a visual representation of the information provided by the Radar GPS, AIS, GMDSS, VTS, while providing the same data as a chart does. It also allows route planning and simplifies watch keeping. One important aspect is that information corrections on these systems are being made electronically, both on CD formats and through the Internet (Weintrit et al., 2007). Although tide tables are the responsibility of the countries that are required to ensure adequate provision of information to ensure the safety of navigation in their national waters, traditionally the UK Hydrographic Office provided a global coverage of tide table data. Nowadays, due to global warming, the tidal stream atlases are still based on rudimentary tidal chart data and more importantly the Pilot publications are increasingly outdated. Advances in ocean modeling have led to radically improved performance in ocean tide and sea level forecasting and current predictions in certain regions of the globe. The GOOS (Global Ocean Observing System), a global system for observations, modeling and analysis of marine and ocean data (Graff 2007), is slowly emerging as operational support for ocean services world wide, and it can be predicted that in the near future reliable information will be readily available for the seafarers.

ARPA is one of the most crucial pieces of equipment found on the bridge. Used to determine if there is a collision risk, the traffic situation around the ship, and her position, radar remains the most valuable tool in low visibility and by night. It usually functions in close relation with the GPS, so at any time it displays the position of the position of the ship.

The next to be discussed is the AIS (Automatic Identification System), a system that allows for easier ship-to-ship communication, because it ensures automatic and direct access to a ship's call sign and name, its IMO number, and other information necessary for safe and secure navigation, while also helping shore based systems like the VTS in their traffic management operation. It usually functions in close relation with the GPS and it communicates to the surrounding ships the main call sign of its own ship, the IMO number, the last port of call and destination port, as well as the position while receiving the same information. Furthermore, it offers the possibility of transmitting messages

between ships or from ship to shore, as well as between shore operations and authorities; thus, it can also function as a source of information.

The radio communication services allowing communication from ship to ship and ship to shore are playing a major role in e-Navigation. It is of vital importance for transmitting and receiving distress alerts, coordinating search and rescue efforts, and receiving signals for locating and for receiving Maritime Safety Information (MSI). Moreover, its importance is underlined by other e-services it provides, such as the service via a satellite system like INMARSAT (Internet communication and satellite-telephony). INMARSAT B was the first digital service (launched in 1993) and remains the core service for maritime industry. It provides fax, telex, and data services at rates as up to 64Kbps, as well as GMDSS – compliant distress and safety functions. This system can be used for data transfer, Internet, E-mail, fax, videoconference, remote monitoring, weather updates, telemedicine, and GMDSS. INMARSAT C is a more flexible satellite message communication system, via a low cost, light-weight terminal (Korcz 2007). While offering the same functions as INMARSAT B, it also may also provide chart and weather updates, maritime safety information, SafetyNet and FleetNet.

4 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 bridges of two or more ships we can see that the deck officer has a multitude of information presented to him at the same time the ECDIS, the Radar, the GPS - and the most important issue of all is that each equipment has features that will distinguish itself from others that are to be found on different ships.

Even though information is readily available on almost every console (for example the position information provided by the GPS can be found at the radar display and at the ECDIS), operating this equipment at a first glance and knowing where on the display is the information that is required should a crisis situation occur and a quick decision needs to be made, the situation as a whole becomes very problematic (Patraiko 2007).

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.

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 (Bibik et al., 2007). 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 (Barsan et al., 2007b).

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 (Hanzu-Pazara et al., 2008). 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 (Barsan 2007a). After that, a discussion and practical explanation session must be arranged under the supervision of senior officers, before the ship will leave the port.

More than that, at least the first 4 to 6 watches of the new OOW must be supervised by a senior deck officer (master) by day and night, in order to teach, assist and monitor the OOW in the proper use of the IBS equipment.

Special attention must be paid to the different alarms settings, which must be explained to the OOW. Moreover, the supervisor must monitor the reactions of the OOW when such an alarm starts. In the same time, the meaning of the alarms and the triggering parameters must be explained to the new OOW.

The layout of the IBS has also a very important role in the behavior of the OOW during the sea watches. From our point of view, the layouts that incorporate two fixed rotating chairs, separated by a central console (“cockpit” design) are not at all a good solution, because they limit the mobility of the officer. Consequently, the OOW is practically forced to sit on the chair in order to have access to all the display and commands mainly during night watches: this “immobilization” could induce boredom and sleepiness (see figure 1).

Someone may say that these factors are not related with the e-Navigation concept: we have to remember, however, that one of the most important objectives of the e-Navigation concept is to facilitate assimilation of nautical information by the bridge team using a very friendly and safe interface.

5 Preparing students for e-Navigation

At Constanta Maritime University we are educating our students with due regard to e-Navigation.

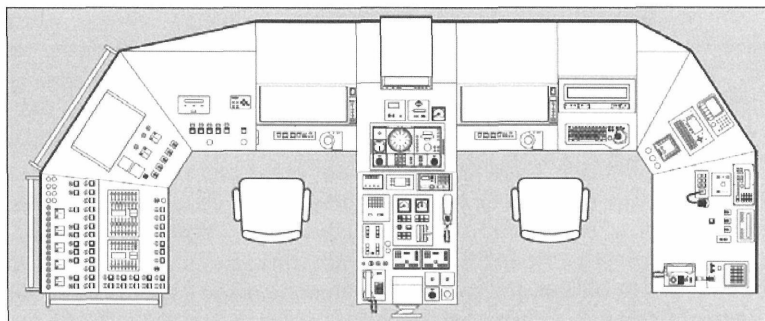
We believe that the maritime officer is a crucial part of this concept and the way they are educated is crucial to their future performances.

In their two first years they learn how to navigate a ship without the use of modern systems. Disciplines like astronomical navigation and coastal navigation emphasize the fact that a ship can be safely navigated with only a sextant, a compass, navigation charts, and a very well prepared bridge team of officers. They gain basic knowledge on theoretical and practical aspects of navigation as a whole.

In the following years their curricula includes Radar Navigation, Radar Plotting, as well as the use of ARPA. At these seminars they are introduced to at least four different radar display types. They learn how to make proper use of the ENC, the GPS, AIS, ECDIS, and the communication services on board a ship.

The most important aspect of their education regarding e-Navigation is represented by the skills they gain by working on our simulator (Raicu et al., 2007) and how to use all the knowledge they have accumulated over the years and to experience situations that they may encounter at sea. 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. Separation schemes must be respected and reporting systems must be followed.

**Figure 1 - IBS “cockpit design” limits the mobility of the deck officer.
(Source: Raytheon Anschütz GmbH)**



Moreover, they are introduced to various scenarios like Search and Rescue, or man overboard, where again they must communicate with one another, with the land stations, and with the air ships.

There are scenarios where the students are expected to determine their position using neither the GPS nor the Radar, but other means independent of the first two. During other simulations various system failures are being simulated (the GPS indicates a false position, or the ECDIS might not function). All this is being done to ensure that these future officers do not panic and know how to deal with the situation, or how to obtain the required information from other sources. We also emphasize that communication is the key to avoid accidents or maritime disasters.

We assume that in most maritime universities, the curricula is very much the same and the above mentioned courses are done more or less in the same manner (Barsan 2007c).

In order to better respond to the challenges raised by the modern ship bridges, during the last two years we introduced a new course for the students from the 4th year of study (the last one). This course is called “Integration of Nautical Information” and is a course that has 100% of its practical applications done on ship handling simulator (SHS).

The main aim of this course is to familiarize students with the use of an integrated bridge system (IBS) and with the best practices regarding the acquisition of nautical data in permanent relationship with ship’s intended track. (figure 2).

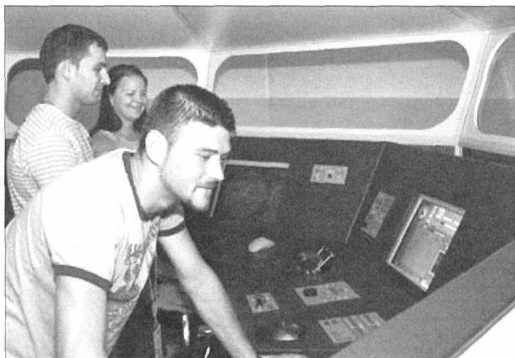
Figure 2 – Students’ team during “Integration of Nautical Information” course laboratory



It is true that nowadays, due to technological advances, navigating a ship has become theoretically easier; thus, the burden on the maritime officer has been decreased, allowing him to concentrate on safe navigation, while future technologies are going to improve safety standards and ease the navigation effort even more. However, we encourage students not to rely too much on the information available from electronic sources like the ECDIS or the radar, but rather to “look out the window” and “take a look around”, to use their senses, as well as making good use of what today’s technology has to offer them

We also teach them what they have to do and how often they must do the required checks in order to determine if the information provided by the electronic equipment is still accurate (figure 3).

Figure 3 - “Integration of Nautical Information” course laboratory



Most of the scenarios that we play on the SHS during this course simulate a normal watch environment with medium traffic and near coast navigation. The scenarios are long (2-2.5 hours) in order to create the feeling of a routine watch, but in a specific moment there will be a triggering event that “will make the difference” and will require direct actions from the bridge team (Barsan et al, 2007b). The main purpose of the initial event is to distract attention of the OOW from the normal routine, while some of the nautical equipment will start to malfunction --, not very conspicuously, but introducing faulty data into the system.

6 Conclusion

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 10 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 absorbed, processed and analyzed in a proper way, in order to determine the right 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 the nautical sciences. We have to develop the student’s habitude to generate his own overall image of the surrounding situation, based on as much information available as possible.

We also have to create our students’ culture for a self-learning process when confronted with new types of nautical equipment and a new layout/configuration of the integrated bridge system. They have to ask for a proper on board training period, starting with enough time to learn and understand the user manuals of the navigation equipment installed in the IBS.

The setback in the training of deck officers to meet the e-Navigation challenges may also be related to the lack of mobility of IMO. On one hand, the IMO MSC is promoting the e-Navigation concept, but on the other hand the STCW provision were not updated for more than 10 years. We still have to deal with compulsory courses of radar plotting, but teaching the use of ECDIS, AIS, IBS, Bridge Team Management or Bridge Resources Management are still optional (Barsan et al., 2007b). If at least some of these courses will become compulsory for the basic training of deck officers, we assume that the bridge team will be better prepared to face the upcoming e-Navigation “tide of information”.

References

- [1] E. Bârsan, 2007a, New technologies for maritime safety – ISBN: 978-973-7872-64-7, Editura Nautica, Constanța
- [2] Barsan E., Arsenie P., Hanzu-Pazara R., 2007b, New navigation competencies required for an updated STCW Convention, Journal of Maritime Studies, vol. 21, nr.2/2007, ISSN 13320718, pag.151-161, Croatia
- [3] Barsan E., 2007c, Key roles played by shipping companies in the MET process, 8th General Assembly of International Association of Maritime Universities - Odessa, Ukraine, published in World Maritime Excellence, ISBN 978-966-8783-11-1, Ukraine
- [4] Bibik L., Królikowski A., Czaplewski K., Duda D., 2007, Vision of the decision support model on board of the vessel with use of the shore based IT tools, 7th TransNav 2007 Conference – Gdynia, Poland, published in Advances in marine navigation and safety of sea transportation, ISBN 978-83-7421-018-8
- [5] Graff J., 2007, The role of operational ocean forecasting in e-navigation, 7th TransNav 2007 Conference – Gdynia, Poland, published in Advances in marine navigation and safety of sea transportation, ISBN 978-83-7421-018-8
- [6] Hanzu-Pazara R., Barsan E., Arsenie P., 2008, Reducing of maritime accidents caused by human factors using simulators in training process, Journal of Maritime Research, Volume 5, No 1, 2008, ISSN 16974840, Spanish Society of Maritime Research (SEECMAR), Santander, Spain
- [7] IALA, 2008, e-Navigation Frequently Asked Questions, St Germain-en-Laye – France, <http://www.iala-aism.org/>
- [8] IMO, 2005, IMO E-Navigation strategy, Maritime Safety Committee, MSC 81/23/10, London, UK
- [9] Korcz K., 2007, GMDSS as a Data Communication Network for E-Navigation, 7th TransNav 2007 Conference – Gdynia, Poland, published in Advances in marine navigation and safety of sea transportation, ISBN 978-83-7421-018-8
- [10] Patraiko D., 2007, The development of e-navigation, 7th TransNav 2007 Conference – Gdynia, Poland, published in Advances in marine navigation and safety of sea transportation, ISBN 978-83-7421-018-8
- [11] Raicu G., Bârsan E., Arsenie P., Hanzu-Pazara R., 2007, Realistic environments for online maritime simulators, 8th EUROSIM 2007 -

Ljubljana, Slovenia, published in Proceedings of the 6th EUROSIM Congress on Modeling & Simulation, ISBN 978-3-901608-32-2, Pub. ARGE Simulation News, Vienna, Austria

- [12] Wadsworth B., 2005, MARINE eNAVIGATION, Maritim Faggruppe, ITS Norway
- [13] Weintrit A., Wawruch R., Gucma L. Pietrzykowski Z., Specht C., 2007, Polish Approach to e-Navigation Concept, 7th TransNav 2007 Conference – Gdynia, Poland, published in Advances in marine navigation and safety of sea transportation, ISBN 978-83-7421-018-8