Computer technologies in shipping and a new tendency in ship’s officers’ education and training

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Abstract. This article presents the results of the authors' work on a project of the European program Erasmus+ “Diversification of seafarers’ employability paths through collaborative development of competences and certification” – DivSea. In this project, the Nikola Vaptsarov Naval Academy is actively involved in partnerships with related maritime education institutions from Romania, Cyprus and the Netherlands. The aim of the project is introducing qualifications required by the marine labour market into the European education and training institutes to ensure transparency and recognition of skills and qualifications to facilitate learning, employability and labour mobility. Transferring the aim to the shipping, we propose to use modern ship communication equipment and computer technology to enable seafarers to access up-to-date training and qualifications at any point in the world. The created and developed training programs by the participants in the project fill the gap created by the rapid development of shipping over the last twenty years and the changes in maritime legislation in this regard. The opportunities for ship Internet delivery at every point of the world ocean are used. These communication technologies enable the training of marine professionals to become an ongoing process.

1. Introduction
The ambition of the International Maritime Organization IMO to reduce the risk in shipping worldwide and to promote safety at sea made ship owners turn to modern information technologies and their application on board ships. This interest also corresponds to the idea of reducing the number of ship crew members, more and more activities being assigned to the so called intelligent schemes. Starting from the beginning of 90-th in the previous century with Capt. Hedestrom and Capt. Gylden publication [1], for example, today the maritime society discuss the ideas of unmanned and autonomous ships. The authors on above suggest the use of an Integrated Bridge System (IBS), which carries out a number of activities in ship handling and observation of the situation around her. According to them, such an organization could be established on the bridge that only one person, the officer on watch, would be involved in handling of the ship, One Man Bridge Operation (OMBO). Today both IBS and OMBO are a fact and their realization was made possible by the implementation of state-of-the-art electronic data-processing equipment on the bridge.
Since this time the mankind made big steps towards today’s unmanned and autonomous ships. Over the last four years, there has been increased activity among the research community in the field of autonomous vessels. At this stage, publications mainly analyze the current state of shipping and the restrictions on the use of autonomous maritime transport on international voyages [2, 3, 4, 5]. Other large-scale publications present the problems faced by large consortia such as “Mitsui O.S.K. Lines,
Ltd. - Nippon Yūsen Kaisha", "Rolls Royce - Kongsberg", “Yara”, "DNV GL". The authors mainly cite the definitions of the concept of "ship" presented in the IMO conventions and resolutions, as well as the role of the crew and its physical presence on the ship. Autonomy criteria have been proposed and adopted, according to which the separation of ships and their belonging to the relevant level has been made [6, 7].

According to J. Witt [8], the following three aims are achieved through the concept of the “intelligent control”:
- reduction of the number of crewmembers involved in the systems’ monitoring and control;
- maximum fuel consumption efficiency due to the precise keeping of the ship on the preset course;
- precise control of the movement of the ship in heavy traffic and near dangers to navigation.

All these publications point out the importance of modern information technologies in the implementation of the above concept, as well as the necessary computer equipment. An adequate education and training related to the new reality in the shipping is also needed. Therefore, deck officers should possess the knowledge and skills necessary for the competent operation and usage of the equipment. In this respect the problem has a bearing on the education, training and post-graduate qualification of marine officers in the field of information technologies.

The DivSea project team developed a blended learning system and analyzed the opportunity of implementation for vocational education and training. The system was developed for the marine sector and comprises modules created for soft and technical skills’ improvement and assessment. A survey was conducted to identify the set of skills required be the end-users. Following the survey, focus groups with marine professionals were organized to identify methods for skills recognition. The results concluded in an E-platform for Blended Learning constructed to allow participants to improve their knowledge and gradually self-assess the level of achievements. The platform is available on the project website all around the World.

2. Usage of computer systems and technologies on board merchant ships and new tendency in vocational education

In his publication in 2017 [9] P. Borkowski presents an original design of an expert system, whose function is to automatically stabilize ship’s course. This is one of the examples how the technologies are placed on board of merchant vessels.

Many researchers are attempting to use different mathematical algorithms that adapt to shipping conditions. Modern information and computing technologies make it possible to implement any scientific idea. Arjid, Dharmender and Jarial [10] have analyzed a number of algorithms and the possibilities for their application in solving data clustering problems. Their study presents an in-depth study of swarm intelligence techniques and is an example of a research approach to the algorithms used in other scientific fields.

Two types of shipboard computer networks are used:
- a shipboard local computer network (LAN) which is not connected to other networks;
- an extended shipboard computer network, connected to a shore-based computer or computer network. Those networks connected to the Internet are classed in this latter type.

In shipping computers are used not only for administrative purposes but also for communication, navigation, control and monitoring of the ship power plant, control of the cargo handling operations and other operations. On modern ships information about the state of the power plant is fed from the control computer to special devices in the accommodation spaces of the responsible personnel, to the navigating bridge or to other specialized spaces. The Norwegian company Ulstein Bergen has even developed a special information system for post-repair monitoring of the power plant from a shore-based office [11]. The system has been designed as a component of the program, called “Information Technologies in Ship Operation”.

Figure 1. Principle scheme of an extended shipboard computer network

In his post in a specialized marine website Julius Patrick Apud describes very well information technology picture on board of modern merchant ships. He says that modern ships contain many different equipment and machinery that are controlled by computers. Systems such as the main engine, fuel delivery, electrical power, accommodation climate control, among others, need constant monitoring. Temperature changes, shafts revolutions per minute, fuel and oil flow rates and consumption, and other parameters need to be observed, recorded and analyzed. By using computers, the task of record-keeping and analytics is easier, which in turn improves performance [12].

The modern ship's bridge is a system of computers that performs all the tasks related to the safety of navigation and the observation of underwater and surface environment conditions around the ship (fig. 2)

Figure 2. Integrated Bridge System
Maritime education is an integral part of the global strategy for the development of world shipping. The seemingly peaceful area of the International Maritime Organization’s agenda faces the challenges of the new era - the gradual realization of the idea of building and using autonomous ships. This fact makes the use of computer technology and the training of seafarers to use them even more relevant.

Training institutions are concerned about providing the most appropriate curricula that will respond to the trainees’ needs. For this purpose, researchers care about updating the teaching curricula to offer teaching materials focused on learning outcomes. Cooperation with business/industry brings value by ensuring relevance of methods and technologies used in training, as specified in the European Commission’s staff working document, “VET for better Skills, Growth and Jobs” [13].

According to the European Commission publication “Rethinking Education Initiative” [14], in order to build skills for the 21st century, efforts are needed to develop soft skills to enhance employability. Soft skills acquisition seems to be essential for flexibility and security of current and further employees. The right skills offer people the potential and confidence to carry out good quality jobs. All the conclusions above are fully related to the shipping and required adequate reaction from the training institutions. This approach allowed DivSea researchers to select the most relevant topics and to develop career guidance tools and learning materials for soft skills and for maritime technical skills.

Researchers collaborated to adopt a unitary system for developing the learning materials. The courses and assessment tools have been integrated in an E-Platform for blended learning available at [http://divsea.cmu-educu eu/][15].

3. E-Platform for blended learning as a part of DIVSEA project
The IMO STCW 78/95 convention generally states the requirements for the training of ship officers to use modern information technologies. The syllabi of the maritime schools and universities, training ship officers and engineers, include subjects related to them. The syllabi of the Nikola Vaptsarov Naval Academy (NVNA) for the specialties Navigation and Ship Engineering contains the subject Information Technologies that is divided into two parts. The main purpose of the training is acquiring skills for using the computer as a universal means of data processing, for using office programs for text processing, spreadsheets, graphics processing, etc. The study of computer networks and work in the Internet was introduced long time ago.
NVNA deliver to the students distance learning module. It’s a kind of e-learning process, which is very popular within the last decade. In the study “The Application of E-learning in Maritime Education and Training in China” X. Chen, X. Bai and Y. Xiao describe well the process in China, which is a model for basic education, higher education, vocational education and so on [16]. Comparing advantages and disadvantages of e-learning and distance maritime education with traditional one, the authors says that advantages are obviously more (fig. 3):

- provides students with abundant learning resources;
- improves the flexibility of learning;
- reduce the learning cost;
- meet different levels, age, and geographic location of the students’ individualized learning needs.

A small team professors from NVNA took part in a European Commission under Grant Agreement — 2016-1-RO01- KA202-024663, ERASMUS+ Strategic Partnership project “Diversification of seafarers’ employability paths through collaborative development of competences and certification”. Main objective of the project is to improve the employability skills and work opportunities for marine workers and to reduce the existing gap between the educational world and labour market by diversification of career paths and skills recognition [17]. The specific objectives are:

1. To build a network to continuously identify the gaps between marine labour market needs and educational field, for establishing unified system for transparency of skills and qualification by cooperation between representatives from both labour market and education.

2. To promote the continuous professional development of educational staff and marine workers in information computer technology methodologies for enhancing diversifications of career paths, by developing innovative practices for improving soft skills through exchanging good practices and collaborative short training periods.

3. To create teaching curricula focused on areas with skill shortages, targeting new professional marine qualifications in accordance with the National Qualification Frameworks, and to define competence standards orientated towards learning outcomes, supported by development of learning resources widely available as online open education resource.

4. Facilitate the recognition and validation of work-related skills and learning outcomes by referencing them to European Qualification Framework and using European Union instruments.

The authors are part of this team and participated very active in creating of e-learning platform for this new for seafarers training courses. Dissemination of project results included creation of website based on Moodle platform (fig. 4), conference in NVNA, pilot training course in Constanta Maritime University.

![Figure 4. Project website http://divsea.cmu-edu.eu/](http://divsea.cmu-edu.eu/)

The following training courses were created in performance of DivSea project:
- Effective Communication;
- Leadership;
- Teamwork;
- Problem solving;
- High Voltage Safety and Maintenance Course;
- DP Maintenance course;
- Cargo Surveyor;
- Marine survey;
- Energy Efficiency;
- Ballast water management treating systems.

All of them are established in three versions – English, Romanian and Bulgarian language version. The interactive education, training and examination is in English language (fig. 5):

![Figure 5. DivSea website Home page.](image)

The education environment, described above is very suitable for distance learning and DivSea project aims are focused on it. The developed E-platform for blended learning is a complex learning environment intended for individual assessment of skills and expert guidance to improve and certify the beneficiaries’ competences. Main feature of the platform is that it is available for onboard training also.

The dynamic change of the information technologies, used on ships, requires solving of at least two problems.

The first one is related to the necessity of constant updating of the syllabi not only in the area of information technologies but also in some specialized subjects. It is necessary to study the latest and most perspective computer software for use on board ships.

The second problem is related to the necessity of constant supplementing and enlarging the scope of the ship officers’ training in the area of information technologies.

E-learning platform is not only sources of information. It also allow the participants in various courses to maintain interactive communication with the instructors and take part in peer discussions. The training information is provided in the form of multi-media products. Moreover, it offers links to sites of organizations and institutions like IMO, United Kingdom Hydrographic Office, United State Coast Guard, World Maritime University, etc. through them any user can get quick and updated information about the latest requirements of current international documents and regulations for special vocational areas.

4. Conclusion

The E-platform for blended learning comprises a set of tools for guiding users in their future career and sections designed for improving their skills and competencies. It includes information not only
about the project but also about the way in which they can create an account, participate in the different courses and even get their training certificates free.

The users can use the platform for preparing for a new career also. All skills have been selected based on the results of the international cooperation between marine labour market, trainees and VET institutions carried out during the first stage of the project, that of the survey. The experts created teaching curricula and assessment materials for recognition of achievements.

The developed model can be implemented for vocational education and training in various sectors, other than the maritime sector. The efforts to involve the main factors as employees, employers and trainers offer a clear identification of needs that will impact to the relevance of the final result represented by the E-platform.

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