

The Impact of Modern Technologies on Maritime Training and Research

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Today we need safer seas and for that we need better trained seafarers. The seafarer's training process starts during university years and continues at sea during training onboard vessels. The training process is based on theoretical and practical knowledge in various university lectures.

The former educational system had a ratio of theoretical and practical knowledge favouring the first. Today, the main objective is to improve practical knowledge or to apply theoretical knowledge into practice. An important role for this transition is played by the use of modern technology, including specialized computer programs and simulated applications performed during the training process. By using simulators, real conditions can be created concerning real work on the ship's bridge and ship's engine room even before being actually there, and in this way, the first encounter with real situations will be more easily treated and managed with adequate skills for the necessary activities of their future duties.

At the same time, the use of research methodologies based on modern technology provides a projection of safety at sea. Many of the actual brilliant ideas dealing with the protection of maritime environment or for new propulsion types were born during different research programs. In our university, most of the PhD students use in their research activities' simulation and specialized programs to study different situations developed in their theses. In this way, there have been developed and studied many ideas and opportunities related to maritime transport and its challenges. Therefore, modern technologies were used for studying the feasibility of the off-shore terminals in the Romanian Black Sea and the impact of environmental conditions on ships in different operational conditions, possibilities to use innovative propulsion systems were studied, such as the kite, and the effects generated by it on ship's stability and governance, and, another purpose was to see what new and improved solutions can be used for ship's refloating.

In this paper we intend to present which is the importance of the latest technology in the training process and research activities in the field of maritime transport and education. Results of these areas of interest are seen every day, and their quantification is expressed by the constant improvement of ships and maritime safety. We want to emphasise that the success of future activities is the result of today's research and training activities.

Keywords: technology, research, training, opportunity, MET, safety

1. Introduction

Nowadays, the maritime training system uses two methods of teaching and training, the traditional way, based on printed texts and courses and the modern way, using computerized technologies, such as simulators, virtual reality and online courses. Both concepts are useful, because not all types of information can be communicated using only the traditional or the modern one.

First, there is the fundamental information, which is better transmitted using the traditional way, where the teacher clearly explains terms, definitions, and formulas and interacts with students for a better understanding.

The main goals of any scholar system are to provide a better training for future jobs and to provide opportunities for innovation through research activities. Both goals can be reached by using the appropriate technology. For training purposes, technology offers the possibility to acquire knowledge in different fields by using practical applications.

Maritime training has reached a great advance in technology which is used in training in the last years. Nowadays training process involves simulators and computerized programs for 90% of the onboard equipments and activities.

Navigation, engineering, cargo handling, pollution prevention and many other maritime related activities are based on the use of simulators for acquiring knowledge and competencies' development. The technological advance helped students to get to know onboard equipments before the direct physical contact, which led to a better understanding of their functioning and an easier accommodation with them onboard.

Technological training has the role to improve the trainees' skills and capacities of reaction in dangerous situations, which is difficult to be provided through the classical ways of training. When it comes to research activities, the last years' changes in the concepts and the principles of maritime activities, led to new opportunities for research. Most of the developments in the fields such as ship propulsion, ship stability, and integrated navigation, have started from a research idea. The future successful activities are developed through research programs and training processes today.

2. The Connection between Technology, Training and Research

Nowadays, computers and computerized programs are a very important part of our life. The computerized technologies are becoming indispensable for many activity fields, computers being part of the educational processes, or even the essence of these.

Various technologies such as simulators, computerized programs and many types of virtual learning such as web platforms and virtual campuses are used today for training purpose in the maritime academic field.

All these have their own history and evolution, some faster, other in time, but all, as single or combined, help to reach the final goal, better trained seafarers for more and secure oceans.

From all these training procedures, the first were the specialized training programs, based on computerized technology and used mostly for designing and studying different processes. Being the pioneers, these programs did not have a very expressive way of revealing the results and in fact, the procedures for obtaining these results were difficult. Having a poor data base, it was necessary for applications to know the entrance data and all usable variables as user. In time, these programs have been improved and in a short period of time they became indispensable for training courses regarding ship design, engine design and engine internal processes, and liquid cargo transfer or in situations that request a detailed study of thermal and tensional processes inside different parts of ship's body.

The next step in the technological development of the training process has been marked by the advanced computerized programs, more complex, with a more realistic presentation of processes and operations - the simulators. Basically, the simulators consist of computerized programs, but the graphical expression is more evaluate, the images offered are closer to reality and in this way, they allow the user to interpret easier the information.

The use of simulation in providing solutions to the problems of risk and crisis management and the optimal use of crew resources has a long established pedigree in maritime training. [1]

The early simulators consisted of real radars, located in a set of cubicles, and fed with simulated signals. Individuals or teams could learn the skills of radar plotting under the guidance of an instructor working at a separate master console. Other navigational aids in the simulator were fairly basic and certainly did not include a visual scene.

Bridge simulators with a nocturnal visual scene made their appearance later and allowed teams to conduct simulated passages in a realistic environment but with only a few lights available to indicate other vessels and shore lights.

Simulator-based training courses were introduced primarily to train the skills of passage planning and the importance of the Master/Pilot relationship. [6] This training initiative developed into the Bridge Team Management courses that are conducted today on many simulators world-wide and contain many of the elements to be found in Crew Resource Management courses developed in other industries, such as aviation. These courses were developed to focus on the non-technical skills of flight operations and include group dynamics, leadership, interpersonal communications and decision making.

The 1980s saw the introduction of Engine Room simulators and towards the end of that decade, cargo operations simulators also became available. These types of simulator have primarily been used to train officers in the handling of operations, including fault finding and problem diagnosis, and increasingly to train teams in the skills of systems, resource and risk management.

Many types of simulator: bridge, engine and cargo control room, have tended to emphasise a physically realistic environment in which these exercises occur, although in the PC-based simulators for training some tasks are increasingly widespread. [9]

In some parts of the world, there have been developed simulators which have very high levels of physical fidelity, for example, multi-storey engine room mock-up and bridge simulators including features such as 360 degrees day/night views, pitch and roll, full vibration and noise effects.

The only mandatory requirements in the maritime domain for the development of the non-technical skills of crisis management are those of the International Maritime Organization's (IMO) Seafarer's Training, Certification and Watchkeeping Code. Table A-V/2 of this code specifies the minimum standard of competences in crisis management and human behaviour skills for those senior officers who have responsibility in emergency situations.

The simulators used in the maritime officers' training are a compulsory request of the STCW Convention and Code in order to provide an increased safety of maritime activities.

The competence assessment criteria detailed within the Code are not based on specific overt behaviours, but rather on generalized statements of performance outputs, and as such are highly subjective and open to interpretation.

Although these standards of competence indicate that IMO recognizes the need for non-technical management skills, both the standards and their assessment criteria are immature in comparison with the understanding of non-technical skills, and their assessments, within an industry such as civil aviation.

The use of simulation and modelling in the innovation cycle demand a higher degree of flexibility in simulation technology than required for the training function. Simulators need to be able to accept input from a variety of model data, and need to be able to interact with other simulators in unusual and unique situations.

Open systems with modular and recyclable components are required in order to mobilize the broader academic, scientific, engineering and corporate communities to integrate simulation and modelling into the innovation process.

Last but not least, the technology used in the actual training process uses the virtual techniques through its components as on-line teaching and web based applications.

The incorporation of the elements of information and communication has been highly accepted and renowned as valuable aspects in the formation process of engineers and technologists.

The advent of on-line technologies coupled with an emerging recognition of the importance of effective teaching are acting together as catalysts to change the face and nature of teaching and learning across all sectors of education. Significant changes appear to be emerging in higher education

and in many components of school education. Through on-line technologies, we finally seem to have the means to create the learning environments that we know work best. The classroom of tomorrow is starting to emerge and it is quite different to the classroom to which many are accustomed. Perhaps the most noticeable difference is in the roles of the participants. Everyone seems to have to do things a bit differently. [8]

On-line learning can be an active and engaging experience. There's not much room for spectating in a well-designed on-line learning environment. Students are encouraged to collaborate and work together. The environment is usually one of a shared learning space with learners attentive and receptive to others in the class.

Move to on-line is coinciding with moves to more authentic learning settings. The on-line technologies encourage and support such strategies as problem-based learning, case-based learning and even work-place learning. The concept of a classroom as a place of learning is expanded as the classroom loses its boundaries. [8]

Learning on-line encourages and supports the development of a range of students' key and generic skills. There are many useful skills that can be developed through networked learning including information literacy, task management and working with others. Learners become self-sufficient and aware of their own role in influencing what is learned. It's all about whom takes responsibility for what is learned.

As educational systems move to embrace new environments and new roles for learners, all with the learners' best interests in mind, teachers and administrators must be aware that change processes are complicated and often fraught with difficulty. Many learners are often not prepared for willing to be self-directed and independent just yet. [3] Learners often need to be encouraged and induced into the changed roles and need to be consulted and negotiated with to gain their cooperation and consent. [7] Today it is difficult to talk about research activity and not to involve any technology. Many of the engineering processes are able to be studied because of advanced computerized and simulation programs. The research activities involve in many sectors the use of simulators and/or modelling programs. If research represents the advanced frontier in knowledge, simulators and virtual environment represents the top of technology.

3. Modern technology impact on maritime training process

The use of the latest technology during the training process in the maritime field has a good impact on increasing safety and security overseas. This impact, as a result of training, is seen in time and evaluated from feed backs received from companies where graduates work after graduation. Another method to evaluate the impact, as general evaluation, is represented by the reports of international organizations regarding safety at sea and from them to extract the percentage represented by our graduates. Either way, using one or another way for finding the impact of the latest technologies used for training, the result is comparable, these technologies proving their role in the most important aspect at sea, increasing safety. [2]

The main technology used for specialized deck and engine officers is represented by the simulators and specialized computerized programs. In this category there are four important simulators, the ship handling simulator, the engine room simulator, crisis management simulator and liquid cargo simulator. Each of them has its own characteristics, allowing the interconnectivity and complex applications creation. For use in interactive situations some requirements must be covered, the most important being to have operational system compatibility, mostly if made by the same producers. Nowadays simulators cover many requested functions for a proper training of maritime officers, as ship handling in normal and dangerous situations, operation of ship engine and auxiliary equipments, land and maritime operations in case of environmental disaster after maritime accidents in coastal waters. All these trainings are compulsory for a properly trained maritime officer, offering options to perform and react according to the situation.

During training, students have the opportunity to practice on simulators during many specialization courses. These applications help them to improve their skills and to reach the proper knowledge level for their future daily duties.

When it comes to the interest raised by simulators, according to the last years' university's statistics, the number of students passing through the simulator training process increases, with good results in their future activity and also with good appreciation received from the shipping companies.

According to shipping companies' feed-back statistics, younger officers with duties regarding safety in navigation, trained on simulators more than two years, are able to react faster in over than 50% of the dangerous situations, then their colleagues trained under the classical style without training on simulators.

In the engine department, this percentage is over 70%, due to simulation applications during training and use of other computerized programs specialized for the use of engine systems.

In the field of online training our university experiences this option through a course for familiarization training for oil tanker ship operation. In this online course, students and already certified seafarers interested to attend a job on a tanker, have the possibility to visualize simulated applications regarding different operations necessary to be known on a tanker, previously reading and learning the correspondent theoretical modules. [10]

Analyzing the results after one year of training in this way, we may conclude that the students who attend this course benefit from a higher understanding than from the classical one, the explanation being in the access possibility from home or from onboard ships by students during the cadets' practice or by the already certified officers on duty. The success is based also on the option to see simulated applications and to be familiar with particular installations and operational procedures characteristic for oil, chemical and gas carrier ships.

In the same way, tankers operating companies increase their interest to take onboard cadets from our university, cadets who prove to have the necessary knowledge and skills in order to work onboard these ships and offering them the opportunity to develop a future career inside these companies with great professional and financial perspectives.

4. Use of the latest technology in research activities

In Constanta Maritime University, the technology is used successfully in the research activities and in the training process. Many of the research programs that request specialized programs or simulators are realized involving both teachers and students. Three quarters of the doctoral studies are based on the latest technology in different proportions. Doctoral theses about innovative ship propulsion systems, reduction of liquid free surfaces effect, new ideas to refloat a grounded ship, offshore oil terminals risks and advantages, were completed by using simulators and research computer programs. There is no favoured simulator used for research activities. All existing simulators in the university at this moment are used for different research programs. Some of the research ideas developed and finalized due to the use of simulators will be presented below.

One of the research ideas involving simulators for the final results was to determine innovative solutions for refloating ships after a grounding event. The principal subject developed in this project was to found solutions for refloating ships totally different from the actual procedures, based especially on the ship's own means.

During the simulation, it is presented the ship's movement towards the area where the grounding event is going to take place. The water depth decreases gradually, and initially, in deep water, the ship maintains her course but suddenly, due to a decreasing depth and shallow water influence, the ship's course has a deflection towards one of the boards, in this case towards portside. [12]

The bottom of the sea chosen for the grounding event is an argillaceous one and it implicates one of the worst situations for a ship to ground on, because it is very difficult for the ship to recover her floatability and to reinstate her floating status due to argil's density and the fact that it is very adherent material.

During the simulation sessions it was noticed that, in spite of all efforts, the ship did not manage to refloat herself by using her own means of propulsion and manoeuvring. During the simulation sessions the engine was used up to 'full ahead' and 'full astern' and the rudder was sequentially used from 'hard to port' to 'hard to starboard'.

A series of parameters regarding elements of aerodynamic resistance have been selected. Initially, the influence of surface wind was not taken into consideration and so, the values of the parameters seem to be influenced only by the lateral force and longitudinal forces created due to the existence of shallow waters that push the ship away from its course. [11]

Another interesting subject developed using simulators was related to the possibility of implementing an offshore oil terminal in the area of Constanta harbour. To obtain clear results regarding the risks for the ship during operation in an offshore terminal, under the particular conditions of the Black Sea, there were used both the ship handling simulator and the liquid cargo handling simulator.

The simulation was developed for different situations met during operation and in concordance with the geographical and weather conditions for Constanta area. There were made five simulations, based on the most frequent winds in the region, for five different loading conditions.

The analysis of simulation results allowed to determine the risk situations that can appear and what operational actions must be taken onboard ship's in order to reduce the environmental factors' effects on the ship during operation and to prevent ships' positioning in a dangerous, possible disastrous situation.

Results of the studied situation led us to the conclusion that the case scenario can be dangerous, because of the wind force and wave height, but also operable if the trim and heel of the ship are strictly supervised and properly corrected, in order to avoid the situation of higher tensions in mooring lines and, in case of more extensible lines, to reach the broken force value. [5]

In the field of innovative propulsion for pollution reduction there is a subject developed using simulation programs, the pollution reduction by using the kite as complementary propulsion. From the foregoing results it is clear that kite propulsion has good results and its use together with the main engine propulsion means a new opportunity, until now considered unconventional.

This method has been tested and the results were considered satisfactory. A dynamically flown kite can generate up to 25 times the force of a static aerofoil or kite of the same plan form area. A kite attached to a relatively low mast also generates a much smaller heeling moment than a conventional sailing rig and occupies much less deck area – making it suitable as a retro-fit also. The uplifting forces of the towing kite also mean that the hull slices more smoothly into the waves, thereby increasing safety.

There are three major advantages of kite rigs as compared to conventional sailing rigs. First, since a kite flies approximately 150 – 200 meters above the water, it works above the turbulent boundary layer of wind over water that conventional rigs must deal with. As power derived from the wind varies with the square of the wind speed, 25-70% more energy is available to the kite.

Kites can power a boat without the dangerous overturning moments inherent in masts and sails. Kites can fly high up in the sky, far from the effects of the waves and of the boat hull, in steadier and stronger wind conditions. Current kites can achieve a lift-to-drag ratio of about 6 to 1, which can sometimes give a boat more versatility and more power than is possible with masts and sails.

Wind technologies are used on ship as assistance to the main engine because the power produced by the wind alone is not enough to move the ship at the contract speed. [4]

5. Conclusions

A successful training is supposed to use all necessary means to reach the goals and competency objectives. The last years' technological evolution imposes changes in the academic training system, more precisely requesting the inclusion of these technologies in the training process as compulsory. In the maritime academic training field, this necessity has been imposed by the crewing market which was interested to have better trained people and at the same time more competent for the new challenges brought by the technological changes arisen on board ships. Not only the maritime field requested applying innovative teaching methods during training, but also connected activity fields, such as port operators, traffic control and maritime business sectors have shown their interest in the use of the latest training procedures.

Applying the latest technologies during the training of future maritime officers with applications in the connected activities will lead in time to a significant reduction of dangerous events at sea, such as accidents or oil pollution, in a percentage of 40 to 90. The most important reduction has been already seen in the pollution area with direct result in the state of the environment, statistics of the last years showing only accidental pollutions with small quantities without significant impact on the marine and shore environment.

Studies conducted by our university regarding the impact of usage of high technology in the training process show a considerable increase of safety conscience compared with the time when training was based only on classical methods. The confirmation of these results has been given by the feed backs from partner shipping companies, which appreciate favourably the present trend in the training process.

We think that in the future the technology will have a higher position regarding safety at sea. The actual technology will be more easy to use by the persons in charge and the results obtained in this way will increase the level of safety and will give a much more profound trust in personal capability to offer a safe environment for others.

The future of the research activities will be focused on the use of the highest technology. This technology will allow researchers to have results impossible to be gained by the classical methods. The research studies in the field of maritime transport are possible to bring, in the near future, totally new solutions for ship propulsion and navigation, with an increased level of safety for the ship, people and environment.

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