

Computer - based Systems for High Speed Vessels Navigators – Engineers Training

D. E. Gourgoulis, C. G. Yakinthos, M. G. Vassiliadou

Abstract—With high speed vessels getting ever more sophisticated, travelling at higher and higher speeds and operating in areas of high maritime traffic density, training becomes of the highest priority to ensure that safety levels are maintained, and risks are adequately mitigated. Training onboard the actual craft on the actual route still remains the most effective way for crews to gain experience. However, operational experience and incidents during the last 10 years demonstrate the need for supplementary training whether in the area of simulation or man to man, man/ machine interaction. Training and familiarisation of the crew is the most important aspect in preventing incidents. The use of simulator, computer and web based training systems in conjunction with onboard training focusing on critical situations will improve the man machine interaction and thereby reduce the risk of accidents. Today, both ship simulator and bridge teamwork courses are now becoming the norm in order to improve further emergency response and crisis management skills. One of the main causes of accidents is the human factor. An efficient way to reduce human errors is to provide high-quality training to the personnel and to select the navigators carefully.

Keywords—CBT - WBT systems, Human factors.

I. INTRODUCTION

INDEED, according to European Maritime Accidents databases, 26% of accidents are due to the human factor (personal judgement, reaction, vigilance, watch out, etc...). This is as significant as external factors (26%) or technical failures of equipment onboard (30%). These percentages are displayed in Fig. 1 and have been collected by Norwegian Maritime Directorate database.

Human factors are affected by two main factors: Stress and workload [1]. On short voyages with short turnover time in port, the participation of navigating crew members in cargo handling in port results in a high workload and could also result in an increased level of stress. On long voyages, problems of fatigue seem more relevant. The amount of duties to be performed by bridge officers when not on watch can reduce the time available for rest and sleep. This can lead to a problem of accumulated fatigue. On longer voyages, officers might be affected by disruption of sleep patterns and reduced quality of sleep due to disturbance/shift of the natural circadian rhythm and due to environmental disturbances.

D. E. Gourgoulis is with the Merchant Marine Academy of Makedonia, Nea Michaniona, GR 57004 Greece (phone: 00302310855504; fax: 00302310855504; e-mail: gourgoulis@yahoo.com).

C. G. Yakinthos is with the Merchant Marine Academy of Makedonia, Nea Michaniona, GR 57004 Greece (e-mail: cgyak@yahoo.com).

M. G. Vassiliadou is with the Merchant Marine Academy of Makedonia, Nea Michaniona, GR 57004 Greece (e-mail: mario@el.teithe.gr).

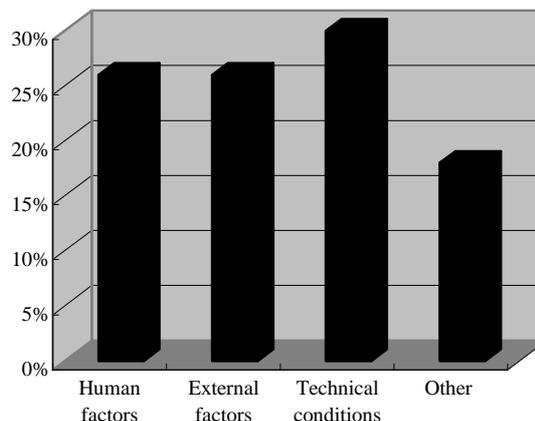


Fig. 1: Main causes of accidents with High-Speed Vessels

Human factors are related to crew competence in terms of decision-making, communication, operating skills. Thus, the human failures can be avoided by different ways: firstly by improving the management and crew organisation; then by doing a careful selection of the crew and thirdly by increasing the training quality and quantity, both for ordinary and emergency situations. The use of Computer-Based Systems would improve both the training and the selection.

II. STRENGTHENING OF COMPUTER BASED SYSTEMS

Computer-Based Systems is a way to reduce cost of seafarer's training, while increasing the quality of training and the comfort of learners. Though, Computer-based Systems is not a new concept, it is still not widely used in the maritime sector and no specific Computer-based Systems exists for fast ships navigators training. The implementation of such training systems, including training on regulations and navigation simulators, would certainly increase the safety.

Computer-Based Systems for seafarers training has been used for several years, firstly in colleges and training centres. Today, due to increased hardware capacities, more and more training means can be available on stand-alone computers. This allows for using computer-based training on board vessels and in the seafarer's home in addition to the training centres.

Computer-based training is therefore a way to reduce cost of seafarer's training and to adapt training to free-time, while increasing the quality of training and the comfort of learners. Though, Computer-based Systems is not a new concept, it is still not widely used and its capacities are far from being fully

employed. Computer-based Systems solutions are today very generic. No one has analysed the needs and requirements for specific high-speed ships training modules.

It has been observed that increasing the training quality would significantly improve the safety of such vessels and would at the same time increase the attractiveness of the shipping profession. With the faster vessel speeds and the consequent need for reduced reaction times, errors due to the “human element” must be fully understood and training regimes should be provided to minimise these risks. Fast ship navigators need a more advanced training than other seafarers: the high-speed induces less time to react and navigators have to be fully aware of regulations, procedures and navigation rules, especially in case of emergency. Besides, such ships are often equipped with high technology navigation aids that require specific knowledge and skills. At the same time, the crew is often reduced and time pressure is an important stress factor. The management and communication within the crew thus has to be faultless. Eventually, navigators on board High-Speed Crafts have to know and apply additional regulations that are specific to their ship (2000, High Speed Craft Code [2]).

Recognising that training is a risk control option, can we argue that further training is required? International Convention on Standards of Training, Certification and Watch keeping for Seafarers ‘STCW95 [3]’ was introduced to lay down a minimum standard for conventional vessels, but it is emphasised that high speed vessels operators need to develop more specific standards to meet identified operational needs. Whilst a number of International Maritime Organization flag states have complied, an extension of the deadline has proved to be necessary in order for certain states to fall in line. Many companies require fast craft officers to have completed their initial training on conventional ships prior to moving to fast craft, in some instances on the operating route, as this gives a good overall appreciation of operational requirements prior to moving to the high speed area.

Training and Certification requirements have been significantly raised since the introduction of the first generation of high-speed craft and as a result incidents and accidents are few. However, when they do occur they tend to be of a higher profile than conventional vessels. High speed vessels officers are highly trained, however, in common with other areas of the marine industry they are in short supply and the pressure to downgrade standards and take short cuts in training regimes is ever present. At this point must be taken into account that International Maritime Organization guidelines [4-7] recognise that automation has qualitative consequences for human work and safety and does not simply replace human work with machine work. Automation changes the task it was meant to support; it creates new error pathways, shifts the consequence of error further into the future and may delay opportunities for error detection and recovery. Automation creates new kinds of knowledge demands. Operators 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 seafarers do not understand the weaknesses or limitations of systems they rely upon. Training in this respect will become more important as systems become more integrated and sophisticated.

The High speed vessel industry can learn from the aviation industry, where safety levels are extremely high, training, management and operational procedures are well developed and are continuously improved. The aviation industry does this by taking a ‘systems approach’ to explain how and why humans behave in a certain way under different conditions. Similar education systems and training should be adopted for the high speed vessel industry where some of the key issues involving the human element include: Assessing human reliability in high demand situations e.g., navigation (inshore/ports), and emergencies such as flooding and fire through the use of simulators and full scale emergency drills. Optimising human performance and behaviour e.g., enhanced situational awareness through better design of communication, control and instrumentation systems. Developing crew understanding of safety management systems and safety culture i.e., development of a pro-active safety culture that promotes communication and team working on the bridge (Crew Resource Management). Learning lessons from accidents and near-misses i.e., analysis of accidents and near misses to develop recommendations for improving safety e.g., by improving procedures by making them more human centred.

Today, no specific Computer - based Systems except from simulator, exists for fast ships navigators – mechanics training. The implementation of such training systems, including training on regulations and navigation simulators, would certainly increase the safety. These systems would include on-shore and on board training and cover topics such as navigation, operational procedures, international and flag-state regulations, navigational equipment use, crisis management, foreign language and etc. Computer-based training systems need to be interactive, user-friendly, adaptive and should be run on a single platform. These systems will help to provide maritime companies with a cost-effective way to train their crew, while keeping high standards of quality. They will be a mean for giving to all crew an extensive and standard training, including modules concerning evacuation procedures and crisis management, which are not sufficiently considered in traditional training. The coordinated development of advanced telematics services (services of catalogue, security, and voice-over-IP), the development of digital content must be used by training centres.

III. DYNAMIC EDUCATIONAL SYSTEM

The computer based education is distinguished in synchronous and asynchronous education [8-9]. The synchronous education requires the simultaneous attendance of all instructors and seafarers. The communication between instructor and seafarer happens in “real time”, and could be exchange either of opinions or of educational material. The simultaneous communication can be achieved either by being at the same place or

being connected through the network that allows the exchange of sound and picture "video conference" while moreover exists the possibility of files exchange and electronic blackboard, materializing in this way Synchronous e-education.

The asynchronous education does not require the simultaneous attendance of seafarers and instructors. The seafarers are not necessary to find themselves assembled together in the same place or the same time. On the contrary, they can select alone their personal educational time frame and collect the educational material according to their needs. The asynchronous education is more flexible than synchronous. Of this type of education are the self-teaching, half autonomous education and the collaborating education. Asynchronous e-education is based mainly on the internet and on the asynchronous access in the course material from the student. It is clear that the appropriate software is needed in order for this to happen. This software is named platform of asynchronous teleeducation or system of management of training material.

As platform of asynchronous teleeducation could be considered also a simple web page in which the professor "loads" the course material and afterwards the students deliver their work through email. Even if this will serve the basic needs, it would not be effective. A platform for asynchronous teleeducation has to satisfy at least the following requirements: To support separation of users in teams so that the same platform can be used for more than one course. Obviously it will support some type of user's certification. To support chat rooms for real time discussion and exchange of opinions, discussion forums for the asynchronous communication of instructor and seafarer, e-mail for the communication of users and the possibility of lecture downloading for personal use. For the professor it is easiest to handout the course material and for seafarers to submit their assignments. The above are considered essential for an asynchronous platform, with the development of technology, the acquired experience and the continuously more demanding user's new features appearance: Printable version of the lecture, a simple web browser without the use of extra software for easy access from different places (internet connections on board) and different operating platforms, user customization with profiles and available help, calendar with important dates (deliverables, exams etc), progress outline, support on-line tests and support multimedia.

DES methodology (Dynamic Educational System) is a platform of electronic education that was developed by Merchant Marine Academy of Makedonia in cooperation with brain.net in 2003 and from then it develops permanently depending on the needs of modern education. It has been used for the past three years with success for the education of officers in Microsoft Office, Microsoft Windows and Internet as well as in technical courses as AutoDesk, AutoCAD and Cisco CCNA. Also have been developed special marine courses on the electronic chart display information system, an automatic identification system. During, this period a large amount of seafarers has been educated with a high rate of success in the examinations. In to 2009 new educational programs will begin in dif-

ferent objects, as student courses but also foreign languages. The know-how that Merchant Marine Academy of Makedonia and brain.net possess in the sector of electronic education is such that allows fulfilling all academic needs.

The platform will use a logical asynchronous communication between the student and the professor. Two architectural levels are essential. In these levels three separate departments of platform will exist. In the lower level will find itself a central server while in the higher level will be found the control centre for the professor but also the application of learning for students.

Beginning from top to bottom the application of learning will undertake the piece of education of students with basic idea the delivery of theory with audiovisual way and not only with delivery of written notes. This is important because of the asynchronous communication and because of the conditions of courses (on board) the platform has to maintain the interest of students high. Apart from the theory the educational application will deliver but also check as long as this is possible exercises while the remaining will be sent to the professor. Also it will present the exercises that have been corrected, when this is judged essential. Here will exist also a mechanism of submission of queries to the professor visible from all the students of each course (as precisely happens in a live department, when somebody has a query).

The professor's centre of control will have a general monitoring of students and their course, during all the courses. From here the professor can correct the submitted exercises but also reply to the queries that have been submitted. Each department of courses that can be altered will be altered by this application, but also each other process relative to the courses, such as intermediary test will be held from here.

Finally, the central server will undertake the transaction of asynchronous communication storing provisionally information that will receive the professor or the student when connected to the platform. This means that the professor can correct an exercise one day and submit it for delivery to the student. The next day the student will receive his corrected exercise and will submit a query. Two days afterwards the professor will answer in the query. The next time the student will try to attend a course maybe due to luck of connectivity he will not be able to connect in the central server. When at some time he accomplishes to connect he will find the answer in his query as well as other comments that have been added from other students that attend the same course. With this way each seafarer can attend the courses with the frequency that his program allows him to and without problems of schedules and different obligations.

Besides, with dynamic educational system methodology, Merchant Marine Academy of Makedonia use full or part task simulation modes for training courses. In the full simulation mode, the program is run on the server, and the mimic panels and consoles in the Engine Control Room and Engine Room are connected to simulation program. The Alarm Station is used for monitoring and controlling of the process. In part task

simulation mode, the workstations are isolated from each other. The simulation runs on each workstation. This mode is normally used for detailed studies of subsystems of the simulator. For instance part task mode can be used for running the Electric Power Plant. Each workstation is also capable of running the complete simulation model i.e. several workstations can control the simulation without interference with the others. Irrelatively to which simulation mode is used, the workstations need access to the hard disk. The engine room simulator plant at Merchant Marine Academy of Makedonia is designed, implemented and integrated by Kongsberg Norcontrol Simulation (Kongsberg Nor control, PPT2000-MC90-III, 1999 [10]).

IV. CONCLUSIONS

The aim is to increase the training quality of fast ships navigators. This human factor has indeed been proved a major cause of hazards occurring to high-speed ships. Higher understanding of rules and regulations, increased awareness of navigational aid capabilities and better knowledge of operational procedures are examples of factors that would increase safety of navigation. Accidents and incidents consequences can also be decreased by using computer-based training on evacuation procedures, crisis management and first aid medical help.

The use of computer based training would be beneficial for all maritime companies: it will improve the image of this sector. This will in turn improve both the competitiveness of the maritime transport compared to air or road transport and the attraction for the seagoing profession. There is today a lack of qualified and young personnel in the maritime sector and especially for the operation of fast ships where there is a high need for qualification. The reduction of the unemployment rate in the maritime field is in fact one of the objectives of the European Union for the coming years. Among other solutions to improve recruiting and motivation, the quality of life of seafarers could be increased by applications of new technology, such as education by distance (computer-based training), which allow for more flexibility and user-friendliness. The use of such new technologies would also highly improve the image of the maritime sector which is often seen as old-fashioned and conservative. This would in turn help to reduce the unemployment rate in the maritime sector and at the same time increase the competitiveness of the maritime sector compared to other transport means often seen as more modern, such as road or air transport. Besides, computer based training can add significant and lasting value to a cross cut of stakeholders which are widely dispersed geographically.

The development and extensive use of computer-based training systems would increase the competitiveness between European maritime companies (including ship operators). Ship operators will be able to provide cost-efficient and high quality training to their personnel. This will lead to an increased use of maritime transport mode both for passenger and freight movements, this mode being more environmental friendly and improving land use through the decrease of road congestion and noise pollution. The increasing competition between

transport means, both for passenger and freight transportation requires higher efficiency of maritime transport means. Therefore, through the years the speed of vessels is continuously increasing in order to sustain their competitiveness. This speed increase as well as a growing need for safety induces questions about how to improve safety. It is known that one of the main factors is crew competency and awareness, which can be significantly improved by higher quality and quantity of training.

Computer-based training would therefore help the European maritime companies, and particularly those operating fast ships, to provide an efficient and continuous training to their crew. This will allow them keeping the high standards of safety that they have achieved in the last decades. At the same time, the cost of this training will be reduced compared to traditional training courses.

ACKNOWLEDGMENTS

The authors wish to thank the Department of Marine Engineering of Merchant Marine Academy of Macedonia, Greece, and the Technical Chamber of Greece for their assistance.

REFERENCES

- [1] D. E. Gourgoulis, G. P. Gotzamanis, C. A. Schinas, X. A. Vouvalidis.: 'Empirical human factors studies on a simulated high-speed vessel' Proceedings of 5th International Congree on Maritime Technological Innovations and research, 2006, Barcelona.
- [2] I.M.O. 'International Code of Safety for High-Speed Craft (HSC Code) (resolution MSC.36 (63))', 1994
- [3] STCW 'International Convention on Standards of Training, Certification and Watch keeping for Seafarers', (IMO Sales No. 938), 1995
- [4] International Maritime Organization, Model course 7.04, 'Officer in charge of an engineering watch', 1999
- [5] International Maritime Organization, Model course 7.02, 'Chief engineer officer and second engineer officer', 1999
- [6] International Maritime Organization, Model course 6.09, 'Training course for instructors', 2001
- [7] International Maritime Organization, Model course 2.07, 'Engine room simulator', 2001
- [8] Holmerg B. 'On the educational potentials of information technology with special regard to distance education' ICDE Bulletin 6, 49-54, 1984
- [9] Brusilovsky P. 'Adaptive and Intelligent Technologies for web based Education' Special issue on Intelligent Systems and Technologies, *Kunstliche Intelligenz*, 4, 19-25, 1999
- [10] Kongsberg Norcontrol, 'Propulsion Plant Trainer, PPT2000-MC90-III, User's Manual', 1999