Research on Crew On-board Electronic Classroom

Xiaobai Liu1,*, Hong Liang1, Xingxing Zhang2
1Shanghai Department, China Ship Development and Design Center, Shanghai, China
2High Vocational and Technical College, Shanghai Dianji University, Shanghai, China
mail-fox@163.com

Abstract. A concept of on-board electronic classroom of surface warship was proposed based on the foreign Navy experience in this paper. The main function and system composition of the classroom was planned, which aimed at teaching on-board, educational administration management, remote support and simulation training, including on-board part and shore auxiliary system. And taking IETM as the information carrier form of the classroom was also put forward in this paper. At the same time, a case design of on-board electronic classroom of Chinese Navy surface warship has been carried out, including system configuration suggestion, using scheme and cabin layout proposal. And that provided a new idea for improving the crew on-borad training level of Chinese Navy warships.

1. Introduction
At present, all the countries in the world attach great importance to the on-board technical training of warship crew. The western developed countries had not only established a perfect on-board technical training system, but also established the modern on-board training platform and facilities, to carry out systematic on-board technical training of crew, so as to further improve the level of crew's using, managing and repairing of warship [1].

In recently, with the development of informationization and intellectualization, the new training methods such as multimedia electronic classroom, remote teaching classroom and simulation training classroom by using of computer resources and network resources, has become the development trend of crew on-board technical training in the developed contries. For example, the crew could learn training materials such as teaching videos and electronic books in the database independently and selectively, and communicate with the shore-based training center through remote communication equipment on-board, by using of the electronic classroom on Type 45 Destroyer of Royal Navy [2], as shown in Figure. 1. A special simulation training class for electromagnetic ejection system was set up on the USS Ford aircraft carrier (CVN 78), as to simulate the conventional and unconventional operation in the process of electromagnetic ejection, for completing the intensive practical training for crew [3]. In addition, the U.S. Navy had developed Delta 3D virtual engine specially for developing crew virtual training system, and had completed the development of virtual training equipment or programs for submarine operations, cabin fire protection, navigational manipulation, damage control and anti-sinking [4-6]. These above electronic teaching facilities and simulation training equipment constitute the electronic on-board technical training system for foreign warships together, which was not only helpful for the crew to re-absorb and re-digest the operation, use and maintenance skill, but also provided a useful platform for fast learning and simulation training of new crew members. All these provide a strong guarantee for the warship to provide and maintain strong combat effectiveness.
Aiming at the needs of crew on-board technical training for Chinese Navy and drawing on the advanced experience of foreign navies, this paper has put forward the concept of on-board electronic classroom, planned the main functions, system composition and information carrier of the classroom, and developed the case design of surface warship’s on-board electronic classroom. And that has provided new ideas for improving the level of on-board technical training for Chinese Navy warships.

Figure 1. The on-board training class of Type 45 Destroyer of Royal Navy

2. The concept of electronic classroom

In 21st century, the electronic classroom has become a development trend of foreign navies to carry out the crew on-board technical training. Compared with traditional land-based classroom, the on-board one has following engineering difficulties:

1) Although the space of warship cabin is limited, it needs to meet the theory and operation training demand. Therefore, it is required that the on-board electronic classroom could not occupy either more space on board or replace the original task function of ship cabins. So the electronic classroom equipment, function and teaching resources need to be highly integrated.

2) As the warship needs to carry out tasks at any time, so that it is impossible to carry full-time teachers, technical experts on-board. In order to satisfy the teaching task, it is required that the on-board electronic classroom could realize long-distance teaching support and shore-based expert technical support without interfering in the normal communication of warship.

Based on above, the characteristics of on-board electronic classroom can be concluded: the crew can use digital teaching resources for self-study in limited space, and getting remote teaching and technical guidance by using of warship communication facilities. Its schematic diagram is shown in Figure. 2.

Figure 2. The sketch map of crew self study and distance teaching

According to this characteristic, the target image of on-board electronic classroom could be concluded. That is an informatization physical platform for crew on-board training, self-study, meetings, skill assessment, simulation training and teaching management, which utilizes computer resources, network resources, satellite communication resources and multimedia data resources. Based on this platform, the main derivative functions of the classroom could be planned as following:

1) It can provide a good physical platform for the consolidation training of old crew and skill training of new crew. That could meet the crew needs of self-taught, self-study, seminar, centralized
teaching and simulated examination by using textbooks, multimedia teaching materials and the Interactive Electronic Technical Manual (IETM), so that enriching the means of crew training, enhancing learning interest of crew and the effect of training.

2) It can set up an on-board training resource bank by use of the classroom database, then digitalize all kinds of teaching resources and store them in the database. So that it can not only improve the utilization rate of teaching resources, but also save a lot of storage space of paper materials and the reduce the cumbersome work of handling, storage and consulting. It plays an active role in improving the utilization rate of cabin capacity and reducing the extra work of crew.

3) It can establish the crew teaching archives by use of the classroom database, and the officers can keep abreast of the crew's familiarity and understanding of warship equipment at any time. Based on that, officers can organize specific enhanced learning and assessment targetedly, to consolidate and improve the learning achievement of crew, and form a benign cycle learning atmosphere of “catch up with others and surpass others”.

4) It can accomplish information exchange with shore-based training support database by use of the classroom telecommunication function, to realize the sharing of shore-ship teaching resources. So that it could realize the functions of remotely teaching for crew training, and provide technical guidance for crew maintenance. It partly realizes the remote assist support function of warship.

5) It can set up simulated training facilities in the classroom, such as the new simulated training system based on Virtual Reality (VR) Technology, Streaming Media Technology, Artificial Intelligence Expert System and so on [7-8]. That could carry out immersion observation, training exercise and simulated troubleshooting on-board, so as to make the crew feel immersed in the situation and strengthen the function of practical training.

3. The composition of electronic classroom
Based on above functions, as the main platform of on-board technical training, our electronic classroom should meet the needs of theoretical training, remote teaching and simulated practical training for crew. So its composition should consist of two parts, such as on-board part and shore-support part, as shown in Figure 3.

As the main part of electronic classroom, the on-board part can build an electronic training platform for crew, which includes three functional units, such as the multimedia teaching appliance, remote teaching equipment and simulation training facilities. And the details of on-board part are as follows:
1) The multimedia teaching appliance includes fixed desks and chairs, teaching LAN, data server, integrated computer client, multimedia blackboard, stereo audio, loudspeaker, network printer and auxiliary equipment, such as network line, network interface box, network switch and wireless router.

2) The remote teaching equipment includes cabin audio and video acquisition equipment, tablet computer, portable maintenance assistant device (PMA) and other wireless display operation terminals.

3) The simulation training facilities includes practical training equipments, storm resistance training facilities, navigation operation simulators, simulation troubleshooting guidance program, virtual maintenance system, combat deduction training equipment and other intelligent and sensory simulated training equipment based on Virtual Reality (VR) technology.

As the minor part of electronic classroom, the shore-support part mainly includes shore-based expert resource bank, remote expert lecture and the information network which is connected with industrial departments and military academies. The shore-support part can be connected to the on-board teaching LAN through Ku/C band satellite communication, to provide fine teaching resources for on-board classroom theoretical training.

4. The information carrier of electronic classroom

With the development of information and intelligence technology, the new information carriers which was based on IETM, VR or other technology, had been widely used by foreign navies. As the important characteristics of on-board electronic classroom is to use digital teaching resources for teaching and self-study activities. So that, we should actively adopt these new information carrier to improve the informationization, lightweight and utilization rate of on-board teaching resources.

Therefore, besides the traditional paper textbooks, electronic documents and multimedia courseware, the studing resources carrier of on-board electronic classroom should take the IETM as the main carrier form as well, which has more informationization, integration and interaction. More than this, the IETM should have a typical fourth-level feature (hierarchical structure), which can be used for crew operation, maintenance and training, and build a technical manuals database to meet whole life cycle management requirements. Through this database, the IETM and paper technical manuals could be published homologously, and the IETM can be installed and used in two forms: network version and single-machine version.

After delivering to troops, the network version IETM Common Source Database (CSDB) will be installed in navy base local LAN or warship on-board teaching LAN for shore-based personnel or crew using. By loading databases and browsers on LAN’s server, the users can browse, inquire and use the IETM through each terminal which can login in the LAN.

The single-machine version IETM could be delivered to troops by means of tablet computers and PMA, which had been installed the IETM CSDB. And the tablet computers or PMA will be placed on board for the crew using. By downloading and updating data packets from base LAN or on-board LAN’s servers periodically, tablet computers and PMA can realize offline display, inquiry and interaction functions of IETM, and provide a technical data support for crew’s operation and maintenance activities. The examples of network version IETM and single-machine version IETM are shown in Figure. 4.

![Network Version](fig1)

![Single-machine Version](fig2)

Figure 4. The examples of IETM
In addition, the streaming media and Extensible Markup Language (XML) should be used as the main information carriers of simulation training facilities in electronic classroom. That could be used to develop various intelligent and sensory simulation training equipment based on VR technology. An example is shown in Figure 5.

Figure 5. Virtual training based on the streaming media

5. The case design of electronic classroom

Based on the above functions and composition of on-board electronic classroom, this paper had put forward a design scheme of the classroom which was suitable for Chinese Navy surface warships, by drawing lessons from foreign navy experience. This classroom was composed of teaching LAN, data server, integrated computer client (including headphones, audio and video acquisition equipment), interactive electronic whiteboard, stereo audio, simulation training facilities and network switch, etc.

As the surface warships have the requirements of rapidity, stealth and combat function, their cabin layout is much more compact than civilian ships, so that it is generally difficult to have enough space to set up independent on-board training cabins in warships. Therefore, this paper had adopted the scheme of sharing the electronic classroom with the soldier's activity cabin, to make full use of the on-board space and improve the utilization rate of surface warship cabins’ capacity resource.

In order to realize the purpose of sharing with the soldier's activity cabin, the cabin shall be priority given to meeting the functional requirements of soldier's activity cabin. Such as, there shall be setting up conference tables and chairs for the crew meeting, setting up closed-circuit television (CCTV) for the crew study and amusement, setting up fixed bookshelves for the crew reading and rest, and setting up movable fitness equipment for the crew physical exercise, and so on. Hence, for meeting the above functional requirements of soldier's activity cabin, our on-board electronic classroom had adopted the layout form based on human factors engineering, so that was composed of fixed conference table, integrated computer client, interactive electronic whiteboard and simulation training facilities. The classroom case design was shown in Figure 6. That could be used for centralized teaching, remote teaching, self-study, simulation training of the crew.

Figure 6. The case design of on-board electronic classroom

The operational program of our surface warship on-board electronic classroom was as follows:
1) There are setting up 16 fixed integrated computer clients on the 2 fixed conference tables, which were according to the requirements of the soldier's activity cabin. So that, they can not only satisfy the centralized meeting of all departments on-board, but also carry out the theory teaching activities such as training, examinations and seminars. Each client can access the crew training application softwares in the LAN's data server through network switch, to invoke training materials, teaching courseware, multimedia teaching materials and exam database by the Browser/Server (B/S) architecture mode.

2) Each client is equipped with a integrated headphone to meet the needs of self-study or remote communication with the shore-based training centres. One of the clients has the simultaneous screen reporting function, and which could be used as the main reporting desk to carry out teaching, conference, seminar and other activities.

3) There are setting up a set of wall-mounted interactive electronic whiteboard and stereo audio, that can not only replace the function of CCTV in soldier's activity cabin, but also meet the crew needs of centralized teaching and watching multimedia teaching materials. At the same time, the whiteboard and audio could be connected with the shore-based training support database by the Ku/C band satellite communication network, to share to shore-based teaching resources. In this way, remote education function and part of Coast-Sea integration support function could be realized.

4) There are setting up 2 simulation training facilities with the crew practical training software, which was based on VR technology or artificial intelligence expert system. So that, the practical training, such as of damage management integrated training, could be done, to enrich the means of on-board practical training.

5) There are setting up a number of bookshelves according to the requirements of the soldier's activity cabin, as be used as on-board librarie or resource center, to providing the functions of paper book reading, self-study, leisure and entertainment for crew.

6) In order to meet the needs of crew physical exercise, a large space should be left in the front of the cabin, to place the movable fitness equipments.

6. Conclusion
The on-board technical training plays an important role in improving the level of crew's using, managing and repairing of warship, to maintain the operational readiness and fighting effectiveness during its life cycle. Based on the experience of foreign warship on-board technical training, this paper had proposed a concept of warship on-board electronic classroom, and put forward its main functions, system composition and information carriers. At the same time, the case design of on-board electronic classroom for Chinese Navy surface warships were carried out in this paper, including its system configuration, operational program and cabin layout suggestions. It had provided a new idea for enriching the means and improving the level of crew on-board technical training of Chinese warship.

References
[1] J. Guan, D. S. Hu, Strengthen Training of Crew’s Maintenance Ability Based on Framework of Crew Level Maintenance Capacity, Journal of Naval University of Engineering, vol.14(2), pp.63-67, 2017.
[2] http://news.163.com/photonew/00AQ0001/10338_17.html
[3] Y. P. Gu, J. W. Qiu, H. Gao, et al, Training Content and Process of New Aircraft Carrier of US Navy, Shipbuilding Standardization & Quality, vol.4, pp.34-36, 2017.
[4] X. H. Deng, Y. M. Zhang, Virtual Guided Training System on The Warship, Computer & Digital Engineering, vol.41(4), pp.580-583, 2013.
[5] A. R. Soltani, H. Tawfik, J. Y. Goulmeras, et al, Path Planning in Construction Sites: Performance Evaluation of The Dijkstra, A *, and GA Search Algorithms, Advanced Engineering Information, vol.16, pp. 291-303, 2002.
[6] Z. Chang, J. S. Qiu, X. S. Zhang, Research of The Virtual Ship Fire-Fighting Training System Architecture Based on Virtual Reality Technique, Chinese Journal of Ship Research, vol.4(3), pp.56-61, 2009.
[7] L. Song, *Naval Remote Maintenance Support Technology and Construction Method*, Ship Electronic Engineering, vol.35(10), pp.9-13, 2015.

[8] Z. L. Lou, *The Research of Implementation of The Streaming Media Forwarding Sever Applied in The Distance Education*, Intelligent Computer and Applications, vol.7(3), pp.153-155, 2017.