S-Mode: Challenges and Opportunities for MET

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ABSTRACT

After more than 10 years of discussion and consultation, the guidelines for standardisation of user interface design for navigation equipment (S-Mode) were approved by the 6th Session of the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR). It has been expected that the implementation of S-Mode would significantly impact maritime education and training (MET). However, the involvement of MET institutions in developing the guidelines for S-Mode has been very limited. This IAMU-funded project investigated the potential challenges faced by MET and the approaches that MET may use for preparation with the implementation of S-Mode. Nine focus group interviews were conducted in four countries. The results show that there has been a severe lack of information available for MET on S-Mode development since the beginning of the discussion over 10 years ago. A wide range of challenges have been identified and possible approaches for preparation for S-Mode implementation have been discussed.

1. INTRODUCTION

The introduction of new technologies on ships is often influenced by the drive for profit seeking through the reduction of crewmembers to reduce labour costs. The industry's continuous effort to reduce cost has led to a shift from labour to technology intensive ships. There is a lag between the introduction of new technology and the provision of training to use it, with many seafarers only receiving training 'on the job'[1]. The inability of many educational programs and training schemes to catch up with the rapidly growing complexity of shipboard technology has presented challenges for human-machine interface considerations [2]. In a questionnaire survey of 819 officers, better training of crew to use ship technology was identified as one of the most important factors for seafarers to confidently embrace new ship technologies [3].

Problems have been identified in the current maritime training system such as unsuitable education and training objectives [4], inappropriate skill assessment techniques [5], and shortage of instructors who are well-trained and up-to-date in using educational technologies [6]. The lack of standardisation in both the training processes and the real vessel technical system has also been discussed in the literature. For example, on-board training programs were identified by Chauvin, Clostermann [7] as crucial to the complex situational decision-making capacity. Sandhåland, Oltedal [8] further examined the emerged errors related to insufficient training as demonstrated by the "incomplete mental models related to the vessel technical systems" despite the existence of the on-board training program. Schmidt [9] investigated different solutions for education and training using simulators. The importance of simulation-based and realistic training has also been stressed by Sellberg [10], Sellberg, Lindmark [11]. The advances in immersive technology and virtual reality provide more options for training programs to be more engaging where navigation operators can execute tasks through using a game controller [12].

e-Navigation was first introduced to IMO in 2006 in its 81st session of the Maritime Safety Committee to address the "*compelling need to equip shipboard users and those ashore responsible for the safety of shipping with modern, proven tools that are optimised for good decision making in order to make maritime navigation and communications more reliable and user friendly*" [13]. This initiative was developed at a time when increasing technologies, especially information and communication technologies were introduced to the shipping industry through manufacturers' adoption of these technologies into their shipping-related products. To support the e-Navigation initiative, six priorities were identified and supported by the IMO, of which the S-Mode was to be developed to address the requirement for 'harmonised presentation' of maritime information under e-Navigation. Specifically, S-Mode supports two of the core objectives of e-Navigation (NAV 53/WP.8): 1) integrate and present information on board and ashore through a human-machine interface which maximises navigational safety benefits and minimises any risks of confusion or misinterpretation on the part of the user; and 2) manage the workload of users while also motivating and engaging users and supporting decision- making. Since NAV 53, there has been increasing discussions and studies around the development of S-Mode amongst the key stakeholders through their respective representative bodies.

The S-Mode concept was first proposed in 2008 [14] through a joint submission by The Nautical Institute (NI) and the International Federation of Shipmasters' Associations (IFSMA) to raise the serious concerns about the increasing complexity and uncoordinated nature of shipboard navigational equipment. In 2016, a proposal on how best to develop guidelines for greater standardisation in the use and operation of onboard navigational equipment was discussed during 3rd Session of IMO's sub-committee on Navigation, Communications and Search and Rescue (NCSR). The proposal was co-sponsored by the Comité International Radio-Maritime (CIRM) and the International Electrotechnical Commission (IEC), as well as the NI and IFSMA, and jointly submitted by Australia and South Korea. The 5th Session of the NCSR established a Correspondence Group on the development of the draft Guidelines on S-Mode, coordinated by Australia [15]. The draft guidelines were submitted to NCSR in 2017 [16].

S-Mode has obvious impacts on MET, although the discussions of S-Mode development in the last 10 years have occurred mainly among the representative bodies of seafarers and equipment manufacturers, for example, [17], [18], and [14], with little involvement from maritime education and training (MET). On the one hand, S-Mode may reduce training burdens and enable greater standardisation of training. There are large number of bridge equipment manufacturers with many models making it impossible for any training institutions to develop training labs for every system. The standardisation would allow simplification of shoreside training programs. On the other hand, there is very limited information available to MET about

S-Mode and how S-Mode may affect education and training, although the draft guidelines were submitted to the 5th NCSR in 2017 [16]. It is likely that additional investment is required to set up the new training program. There are also concerns that over-emphasising standard mode may result in inadequate education and training on essential knowledge and skills on which S-Mode is based. It is, therefore, critical to thoroughly exam the challenges of S-Mode implementation MET may face, and approaches MET may take to be better prepared for this significant new initiative.

2. METHODOLOGY

Since little information was available on how MET should respond to, and prepare for, S-Mode, the project employed two data collection methods, focus group interviews and a Delphi study with participants from MET institutions. This paper reports the findings from the focus group interviews. The purpose of the focus group interviews was to identify the challenges faced by MET based on S-Mode and to investigate the approaches for the implementation of S-Mode in MET settings. The outcomes of the focus group interviews were analysed using NVivo [19], a qualitative data analysis software developed by QSR International. The results of the analysis then became the input for the second phase of the project.

To reduce the logistical complexity of conducting face-to-face focus group interviews, a decision was made to leverage the locations of the three project partners, that is, to recruit participants from the project partners' institutions and other institutions that were manageable by the project team. The number of focus groups chosen from the selected countries (Australia, China, Canada and the United States) was determined by the overall number of maritime education and training institutions in the four countries. Initial contact was made to MET institutions to seek their interest in participating in the focus group interviews before invitation letters were sent to prospective participants in the selected MET institutions. Given the topics of S-Mode, it was decided that the invited participants would need adequate seafaring and maritime and training experience. This important criterion was followed when compiling the contact list for sending the invitation letter as well as when finalising the participants of the focus groups. In total, nine focus group interviews were conducted, of which five in China, one in Australia, one in Canada, and two in the United States. Group interviews, consisting of 5-7 participants, were carried out face-to-face except for the two in the United States (Table 1).

A list of nine questions was developed based on the literature review. The questions were provided to all participants prior to the commencement of each interview. Consent for recording was obtained before each interview session. Each focus group interview was coordinated by a facilitator whose main role was to facilitate the discussion in an unbiased way and to ensure participants were given equal opportunity to express their viewpoints. The sequence of the discussions on the nine questions followed more on the logic of the discussion flow rather than the actual sequence of the questions listed. This approach ensured that the group interviews were smooth, and the discussions progressed naturally without interruption by suddenly moving one question to another.

The length of interviews ranged between 63 minutes to 116 minutes with most interviews (6 groups) being completed within 70 minutes. In total, 664 minutes of discussion were recorded. The recordings were sent to two professional transcription service providers, one for the interviews in English and the other in Chinese. The 664 minutes of recording resulted in 132,785 words in transcripts (Table 1). The Chinese version of the transcripts was translated into English before all transcripts were analysed.

Table1 Focus group interviews (participant number and length)

Group	Participants	Length (minutes)	Transcript (words)
1 (AU)	5	67	10,168
2 (CA)	5	76	12,091
3 (US1)	3	66	7,706
4 (US2)	2	68	10,897
5 (DL1)	5	63	18,440
6 (DL2)	5	116	25,517
7 (QD)	5	65	14,716
8 (SH)	6	75	17,646
9 (GZ)	5	68	15,604
Total	41	664	132,785

3. FINDINGS AND DISCUSSIONS

3.1 DEMOGRAPHIC INFORMATION AND INTERVIEW SESSIONS

The demographic profile of the participants is presented in Table 2. Two pieces of demographic information were collected. One was the seafaring experience of participants including the level of Certificate of Competency (CoC) and years of seafaring experience. The other was the teaching and training experience of the participants in years. For seafaring experience, out of the 41 participants, 37 were Master Mariners (Unlimited) representing over 90% of the participants with remaining holding other certificates of competency. The years of sea time ranged from 6 to 28 years, with a majority (56.1%) having 10-20 years of seafaring experience, over one third (34.1%) of more than 20 years and less than 10% sailing for less than 10 years. For teaching and training experience, over 63% of participants had been teaching or training for 10 to 20 years. About a fifth of the participants (8) had taught for over 20 years, and the remaining (7) had been in the maritime training and education for less than 10 years. The extensive experience of participants in both seafaring and maritime education and training provides the confidence on the quality of the discussions in the interviews and thus the information collected from the focus group study.

Table 2 The profile of participants in the focus group interviews

	Seafaring experience No. of participants (% of total)	Teaching/training experience No. of participants (% of total)
Master Mariners	37 (90.2%)	-
Other CoCs	4 (9.8%)	-
Over 20 years	14 (34.1%)	8 (19.5%)
10-20 years	23 (56.1%)	26 (63.4%)
Less than 10 years	4 (9.8%)	7 (17.1%)

3.2 CURRENT CHALLENGES OF MET

During the focus group interviews, a large number of issues were raised and discussed. Some of these were common across all MET institutions while others were specific to individual institutions. Differences were also observed between countries. The analysis of the discussions resulted in four topics related to the current challenges of MET including: 1) organisation of training; 2) current systems used in training; 3) challenges in maritime training and education programs; and 4) challenges in operating onboard equipment.

Organisation of Training: Among the participating institutions, the levels of program offerings vary with some institutions providing bachelor's degree programs only, others offering certificates and/or diplomas (and advanced diplomas), and some offering a very wide spectrum of programs from Cert I to PhD level and everything in between. For STCW related maritime education and training programs, the governance structure may have multiple layers depending on the offerings. In addition to meeting the general regulatory requirements for higher education or vocational education and training, all STCW related programs must comply with the requirements set by the maritime safety administration or authority of the respective country. While the STCW provides the minimum requirements on education and training of seafarers, the actual administration may differ with some having little intervention in program delivery while others being more involved with. The role of the national or state maritime safety administration may significantly affect the way training is organised and delivered.

Current systems used in training: Systems used for training include simulators and real machines. For simulation systems, all participants reported that 'mainstream' brands and equipment are used. Some institutions also develop their own simulation programs or source from providers other than those 'mainstream' manufacturers. For some VET institutions, updating the main simulation program could be a significant financial burden. Consequently, the update may not be at the optimal level. Unlike simulation systems, real machines have very large numbers in varieties, brands, models with some being relatively new and others being up to 60 years old.

Challenges in maritime training and education programs: The most prominent challenge in maritime training and education on bridge equipment operation is the vast number of onboard equipment and the models that come with it. While the basic functions of the same equipment remain the same across brands and models, the way they operate may significantly different. Given the time and resource constraints, MET institutions can only use ‘mainstream’ equipment for teaching and practical training. The associated issue with the diversity is the pressure on MET to expose students to different equipment as much as possible. However, this may bring more confusion to students. The increasing complexity of on-bridge equipment is another challenge. With the fast adoption of advanced technologies onboard ships, the demand for skills on seafarers has been increasing. This has placed significant pressure on MET. While all groups were concerned about the differences between the implemented training systems and the actual systems onboard the vessels in the real world, MET institutions can only provide training with what is available and to the extent to meet the STCW. The variety and complexity of navigation systems requires on-going training or self-learning of seafarers to be competent on what they operate. This is not always possible. The USA group revealed that there were obstacles in continuous training of their students after they have finished their training courses.

Challenges in operating onboard equipment: All groups raised the concern about the complexity and fragmented adoption of onboard systems both across different ships in general, and on the same individual ships specifically. This issue can hamper the decision-making ability of both students and seafarers alike leading to serious safety concerns. The continuous introduction of new functions into the already complicated system further amplifies its complexity. The increasing complexity requires the operators to have a thorough understanding of the equipment under operation in order not to miss any important information. Participants also expressed the concerns about possible over-reliance and emphasis on electronic equipment at the expense of experience. The reliability of electronic devices on the bridge is another concern. The reliability may be related to the performance standards of the electronic devices, which could be a problem as the speed of introducing new equipment may be faster than the updates on performance standards.

The current onboard alarm systems attracted considerable attention and discussions among all groups. The first issue is the inconsistent meanings attributed to alarms with various visual or audial signals in different volume levels, frequency, and tone. The extent of the problem may depend on the experience of the person in concern. Furthermore, the pitch, volume, and frequency of alarms can be very distracting and annoying. The reliability of the alarm system itself can be a weak point. In some cases, extreme measures may be used to ‘silence’ a faulty alarm. These actions and reactions toward alarms may pose serious safety risks. Moreover, the complexity and uncoordinated nature of alarms on bridge brings further issues. To make it even worse, manufacturers from time to time add more alarms to their equipment.

3.3 CHALLENGES OF MET FOR THE IMPLEMENTATION OF S-MODE

It was a consensus among all focus groups that information on S-Mode was scarce, be it the S-Mode itself or its development. Consequently, the discussion on this topic was very limited. Most of the comments were about the absence of information on S-Mode and how this may affect their preparation for the implementation. Equally, it is difficult to identify the possible challenges for training on S-Mode. In addition to the concern about the lack of information on

S-Mode, some groups expressed the concerns about the potential cost associated with the implementation of S-Mode and potential resistance to S-Mode. Standardisation, if not managed properly, may impede the motivation for innovation and continuous investment in research and development. Another concern is the protection of intellectual property where mandatory standardisation may deprive the intellectual properties of some products.

While there was a concern about the timeframe of S-Mode implementation which may not allow enough time for MET to prepare for appropriate resources, the other side of the concern was the inefficiency inevitably exists in the process of regulations and the time taken for enforcement. If this occurs, a new system may be very much outdated when it is put in place. The possible over-reliance, either intended or unintended, on S-Mode may cause safety concerns among MET. This could also create tension between teaching the conventional and essential principles of navigation and the simplified operation of navigational systems. While some believed that S-Mode may reduce the complexity and difficulty of training, others stated that standardisation may also bring negative impacts on MET. Over-reliance on S-mode may compromise the ability of operators in solving problems in complicated situations.

3.4 SUGGESTIONS ON THE IMPLEMENTATION OF S-MODE BY MET INSTITUTIONS

All groups suggested that the maritime education and training institutions should have been given more information about the S-Mode and its development and implementation. It is also important that educators or instructors have hands-on experience before they go and teach students. While standardisation through S-Mode may reduce the time to train people to operate onboard equipment under standard mode, specific training is still required to ensure safety. As educators and instructors, it is unclear how the training will be performed for S-Mode, through simulation or hands-on experience. It was suggested by one group that the training on S-Mode should come after students have gained enough knowledge and skills. In addition, with increasing information and communication technologies being adopted in ship design, students coming to the nautical sciences courses should have adequate knowledge on computer.

In addition to training provided by MET, the shipping companies should also take respective responsibilities to ensure that all crew are provided with necessary training especially skills related to the specific features of the ship. It is important to understand that every equipment or system has its own limitations. Underestimating or ignoring the limitations of onboard equipment may pose serious safety risks. For the MET institutions to be better prepared for S-Mode, a collaborative approach among all MET institutions was suggested.

4. CONCLUSIONS

Current challenges faced by MET are mainly related to the increasing complexity of the onboard navigational systems resulted from the continuous, yet uncoordinated innovations introduced by different equipment manufacturers. There are constraints in financial resources to keep upgrading equipment for training and time limit to exposure students to all brands and models of onboard equipment. It is unclear among MET institutions as how S-Mode may impact the existing training scheme. However, the consensus from the focus group interviews is that information on S-Mode is scarce and that MET should be provided with more information in a timely manner. A forum accessible to all MET institutions may be beneficial for knowledge sharing on S-Mode implementation and training preparation.

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