THE EFFECTIVE USE OF TECHNOLOGY – SOME IMPEDIMENTS AND SOLUTIONS

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ABSTRACT

Shipboard operations, as well as Maritime Education and Training (MET), now have a wide range of technology available to enhance their effectiveness, but there are still impediments. In broad terms the paper addresses issues including crewing structures, seafarer qualifications, as well as training and assessment technologies. Specifically, the paper examines how some impediments to the effective use of technology could be resolved to enhance economic efficiency and effectiveness. Within the context of both shipboard operations and MET, the key objectives of the paper are to:

- Consider the use of technologies;
- Examine impediments to the effective use of technology; and
- Identify potential solutions to enhance the effective use of technology.

Two overarching impediments to the effective use of technology aboard ship were identified as crewing structures and the rigidity of the certificate of competency structure. In the context of MET, overarching impediments to the effective adoption of technology were identified as conservative approaches to teaching and assessment, as well as perceptions and tradition. Many of the specific impediments which were identified could be categorised as being due to the unintended consequences or rigid interpretation of STCW. Potential solutions identified by the research included:

- Identify precisely what the 'modern' seafarer does or should do.
- Devise crewing structures which better reflect the use of technology and focus on what seafarers actually have to do.
- Reorganise the certificate of competency structure to recognise the wide range of skills which are required, e.g. shipboard equipment specific skills, vessel type specific skills and generic skills common to all vessels, as well as those skills required to effectively carry out duties within the industry and society.
- Use technology to improve the quality of teaching, assessment and feedback in MET institutions.
- Strengthen STCW to reflect the way in which the use of technology can enhance the effectiveness of shipboard operations and training, e.g. provide options to integrate within the STCW framework, create multiple pathways etc.

Keywords: *Crewing structures, certificate of competency structure, maritime education and training, MET, maritime technology impediments and solutions, STCW.*

1. INTRODUCTION

The relentless use of technology to enhance efficiency continues to increase. Technological innovations and solutions are progressively more powerful, have become more reliable, are widely available, and have become cheaper over time. Shipboard operations, as well as maritime education and training (MET), now have a wide range of technology available to enhance their effectiveness, but there are still impediments.

In broad terms, the paper addresses issues including crewing structures, seafarer qualifications, as well as training and assessment technologies. Specifically, the paper examines how some impediments to the effective use of technology could be resolved to enhance economic efficiency and effectiveness. Within the context of both shipboard operations and MET, the key objectives of the paper are to:

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2. TECHNOLOGY AND ITS APPLICATION

2.1 Technology aboard ship

The progressive introduction of technology aboard ship over the past century has led to greater specialisation of ship types. The more specialised the ship, the less flexible its use becomes and significant changes to the roles, skills and number of the crew are needed [1].

The use of technology aboard ships falls broadly into four categories, namely: navigation systems, engineering systems, cargo systems, and communication systems. Traditionally these systems have been treated separately, however, as automation and reliability have improved, these systems have become progressively more integrated. Crew members are increasingly dependent on technology based systems which requires them to accurately interpret and use data, monitor the systems, and correctly react to alarms. This surely requires a re-evaluation of the roles and skills of the crew, and the development of appropriate organisational structures to reflect the use of technology aboard ship.

2.2 Technology in MET

Education is in an era of rapid and sustained change and the old paradigms are being replaced by new paradigms. The traditional primary medium for knowledge, books, is being rapidly replaced by information on demand from the internet; learning in a classroom is being replaced by the capability to learn anywhere; and technology is no longer viewed as an expense, rather it is viewed as a differentiator amongst learning providers and is also an important, almost essential tool for the facilitation of learning services. MET operates in this changing educational environment and, in this respect is no different from other providers of education and training services. [2].

In our present age of continually evolving desktop, laptop and tablet computers, smartphones, internet access and social media, the use of technology in learning and teaching presents many challenges. Not least of these challenges is finding one's way through the maze of information resources and choosing the most appropriate technology to use to enhance the learning process. Ten years ago Newhouse [3] suggested, "We need to prepare students to learn, work and live successfully in a knowledge-based, global society." The question for MET is, have we done this, and if not, why not?

3. IMPEDIMENTS TO EFFECTIVE USE

3.1 Impediments aboard ship

Unlike other compatible industries, such as the aviation industry, the maritime industry tends to 'hold on' to older practices, despite the introduction of new technology. Modern technology has made equipment and platforms significantly safer and more reliable, however on board practices have been slow to adapt and take advantage of these changes, as the crewing structure, crew competence and training regimes are reluctant to modernise and embrace change. Although some argue that this is due to the hazardous nature of the industry, compare this to the aviation industry where technology has made the flight engineer redundant, while most harbour tugs continue to hold on to a dedicated on board engineer.

Such practices beg the questions: Why do we yet hold on to the old? What prevents us from changing? Are there internal and/or external factors affecting these changes? A general perception is that seafarers are traditionalist and function within a highly regulated industry. But the reluctance to change cannot be explained in such a simplistic manner. The industries surrounding seafarers are changing, ships have changed significantly, and those servicing the industry have adapted to weather the economic and social changes. A cursory glance at the ship building, ship repair, logistics, and supply industries clearly show transition. This in turn has affected the training regimes targeted at those sectors, greatly benefiting the employers as well as employees. There is a significant shift in education, both upwards as well as in breadth.

A reason why the personnel within the seafaring industry are reluctant to change is the rigid and authoritative hierarchical management structure prevalent in most ships. This is possibly a carryover from the naval links in the past and a perceived need to have absolute obedience to avoid dangers at sea. However, a number of aircraft crash investigations have shown that such management structures in high stress situations can lead to accidents [4]. This is now being recognised within the seafaring industry with attempts to address such situations through research targeting bridge and engineroom crew interaction and their effects on marine accidents [5], resulting in mandated training programmes for crew dealing with such scenarios [6].

To summarise, the crew aboard a ship are compartmentalised by rank, i.e. officers and ratings, and by function, i.e. deck, engine and catering/hotel. However, as shipboard systems are increasingly integrated and become more technically complex, there is some evidence to suggest that the current organisational structure of crews is becoming less relevant to the effective operation of many technically advanced ships. Put simply, the traditional approach to shipboard organisation has failed to keep pace with the changes being wrought by the increased use of technology aboard ship. This is not surprising, as shipboard organisational structures reflect a well tried traditional approach, however the digital age with its sophisticated technology calls for a different approach.

The shipping industry is a global one, with international trade resulting in ships crossing national jurisdictions, each having different and sometime contradicting requirements. International trade regulations and shipping laws attempt to create a common set of rules that allow ships to operate in this otherwise complex environment. Although these rules are developed to meet the needs of all nations concerned, in reality they form a series of compromises and concessions, which usually provides little if any room for innovation, with most outcomes favouring a traditionalist approach where changes are carried out in stages and small steps in an attempt to gain consensus and acceptance.

The international rules governing seafarer certification, competencies and training are defined in such an agreement, the International Maritime Organisation (IMO) International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) [6], and is reflective of the above sentiments. Thus, the competencies stated in the convention are a compromise between the desire to adapt and change to meet technological advancements, environment needs and modern society; and the need to accommodate the capabilities and wishes of the vast majorities of the signatories [7]. In some cases, the stated competencies are obsolescent, inappropriate, and/or inadequate to deal with modern technology and practices. An example is the increase in electronic/electrical equipment on modern vessels not being matched by the associated manning and training requirements.

The pathway to achieving the highest certificate of competency is lengthy, as it requires seafarers to complete both approved STCW specified training programs and sea service [6]. However, just what is the purpose of sea service and how it is to be conducted is ill defined. Is it to gain experience of real life shipping; is it to learn and practice skills which cannot be readily learned or practiced elsewhere; is it to demonstrate skills learned; is it tradition; or is it all of these? [8].

Whilst there is little dispute over the need for sea service experience, there is considerable evidence to suggest that the quality and purpose of sea service is not taken as seriously as it should be.

The competencies within the standards are highly skewed towards the technical attributes, rather than providing a proper balance between technical and generic skills. Most graduate programmes in developed countries place equal value on both set of competencies [9], however most maritime programmes explicitly focus on the technical skills, while a few attempt to address the generic skills, although most when quizzed struggle to explain how these skills are delivered, assessed, or monitored. Again this is a symptom of inadequately designed competency standards, evident when compared against those in other industries, where many have embedded generic attributes, while others clearly identify them as mandatory attributes [9]. Although many within the seafaring profession would argue that this is not critical to the industry, others would beg to disagree, stating that generic attributes provide graduates with the knowledge and skills to broaden their horizon and seek innovative and modern solutions, essential to those willing to encompass new technology and methods [10].

The certificate of competency structure is rooted in history and has served the shipping industry well. However, as ships make greater use of technology, it is observable that there are significant changes to the roles, skills and ways that crew carry out their work. As new technologies are introduced, the IMO slowly includes more and more requirements for certificates of competency; however little that has become irrelevant is removed. It is postulated that the certificate of competency structure in its current form is too rigid to accommodate the full and effective use of some technologies. The structure is still predicated on the traditional one size fits all approach.

3.2 Impediments in MET

A comment by Northage [11] highlights an inconvenient truth, i.e. “Unfortunately proper teaching is what we have been short of for a very long time in all but a few privileged institutions and for the fortunate few aboard ships with people aboard in a position to do it”.

Education institutions are moving away from classroom delivery towards the greater use of delivery technologies. Teacher centric learning is being displaced by student centric learning as students utilise technology to move away from being passive learners towards being active learners. However, many marine administrators and MET teachers have a conservative view of education and training which is based upon their own limited, teacher centred learning experiences. Marine administrations are responsible for the implementation of STCW and, in the context of seafarer training, are responsible for approving and auditing training institutions including staff, facilities and equipment, as well as courses. It is within these systems that clashes between current education practice and administrative interpretations can be observed [8].

As previously stated, STCW [6] attempts to define what seafarers must be able to know/do to be deemed competent. However, STCW is the result of a process of compromise and is also cumbersome to update. The compromise between traditional and emerging knowledge, skills and technology leads to the conclusion that STCW in its current form has the potential to impede teaching what is genuinely relevant.

There are a number of reasons for MET not to have fully embrace technology, and in many cases the blame does not lie purely with the MET providers, as they are constrained by the restrictions imposed by marine administrations and the reluctance of the industry stakeholders to change and adapt [12]. Generation Z is considered to be the most electronically connected generation having been born into a digital world. However, most MET providers are reluctant to embrace innovative technologies or strategies, again a reflection of the perceptions and perceived views within the industry. Unfortunately, this is a double edged sword, as the reluctance to use technology that is part of the everyday world of the newer generations also acts as a barrier in attracting and retaining high performing students from these generations.

Many MET providers struggle to find the correct balance between vocational training and academic education when developing, delivering, and assessing seafarer programmes [13]. This stems from difficulties in understanding the differences and synergies between the two, and preconceived ideas of those within the industry and MET on what the competencies should be and how they can be achieved. Knowledge is the underpinning component of competence [10], and MET providers must use a raft of strategies to impart these to the students, which should include a mix of tools, including modern and innovative technology. The provider has to think beyond the standard boundaries realising that different students learn in different ways.

A further impediment can be the IMO model courses. These are designed asguides for teachers upon which they can build and develop appropriate teaching and learning experiences. However, in a number of countries marine administrations have taken the pedagogically restricting view that the courses they approve must follow exactly an IMO model course. The highly prescriptive nature of model courses, which focus on classroom based, teacher centric learning and the number of hours required to achieve competencies, is at odds with the competency based approach espoused by STCW 95 [6]. This prescriptive approach also restricts the use of technology as a means of expanding delivery methods and enhancing learning outcomes.

Maritime educators and trainers are generally hired because of their maritime skill sets and experiences, and reputable MET institutions generally provide some form

of training to assist their employees to become good teachers. Traditional face-to-face teaching methods can be enhanced or replaced by innovative blended learning methods which use the right technology to provide good pedagogy. But how many MET institutions provide professional development for their employees in blended and flexible learning techniques, instructional design and the use of appropriate technologies to enhance the learning process? Holt et al [14] suggest that information literacy has been, and remains a fundamental skill for educators but digital literacy, as an essential skill, is still gaining momentum.

Thus it is possible to conclude that MET is conservative by nature, wrapped up in quasi-legal and administrative constraints, provides limited opportunity for teaching staff to learn/enhance teaching skills including the use of technology and has a traditional teacher centred approach to learning; all of which reduces its capability to provide what the student requires, when, where and how it is wanted [2].

4. SOLUTIONS TO ENHANCE THE EFFECTIVE USE OF TECHNOLOGY

4.1 Solutions aboard ship

A fundamental solution is to devise crewing structures which better reflect the use of technology and focus on what seafarers actually have to do. This willentail a total revision of the organisation, roles and skills of the crew. It will mean that crews on different ship types may have different organisational structures, roles and skills. It will also mean that the certificate of competency structure will need to be reorganised to recognise the wide range of skills which are required, e.g. shipboard equipment specific skills, vessel type specific skills and generic skills. In addition, STCW will need to be strengthened to reflect the way in which the use of technology can enhance the effectiveness of shipboard operations and training, e.g. provide options to integrate within the STCW framework, create multiple pathways, etc.

To identify the changes needed aboard ship, socio-technical design techniques are useful as they deal with the interrelatedness of social and technical aspects of an organisation as a whole and emphasise achievement of both excellence in technical performance and quality in people's work lives [15].

It is important that the global maritime industry develops clear and appropriate competency standards targeting the roles of the modern seafarer on modern ships. It is accepted that a significant number of ships across the world are dated or use older technology. However, the industry has to look forward and prepare the workforce for the future. Thus, STCW must have clear and targeted competencies for the relevant performance outcomes, linked to the appropriate attributes to enable and assist MET providers to develop suitable programmes.

The technology of today and that on board ships, together with the technology savvy younger generations, offers the industry and MET institutions a number of opportunities to provide innovative education and training [13]. However, the on board environment has to be conducive to such training, with the ship's operators and crew realising the need to train students and provide them with access to the relevant technologies. They cannot hide behind …'that is how we learnt the ropes'… or …'they got to start at the bottom'… to deny trainees access to the required technology, systems, or programmes. Not only do operators and crew need to realise the changes in technology and procedures, but also the changes within the social and generational evaluation processes.

However, changing the perceptions and attitudes on board ships alone will fail to achieve the desired training objectives if marine administrations are unable due to legislation, or unwilling due to perceptions, to accommodate and encourage modern practices. This is where IMO through appropriate conventions and regulations such as STCW can guide the industry to create an environment that is conducive to modern training needs, and is adaptive, flexible, and tolerant to meet the changing needs of the industry, society, and the modern seafarer student [12].

4.2 Solutions in MET

To be educationally sustainable and provide its users with relevant services, education and training providers have to successfully negotiate a number of educational paradigm shifts, pedagogy and technology challenges. Using technology to improve the quality of teaching, assessment and feedback in MET institutions is an absolute necessity.

For too long, MET providers have hidden behind the regulations to resist change. As stated previously, the regulations can stifle innovation. Providers, or more accurately instructors, tend to favour 'tried and tested' methods for training seafarers [12]. Whilst new technologies are utilised, for example the use of simulators, they tend to be used as a tool to deliver the same old curriculum [12]. Providers need to move away from this mindset and look at developing training focused on the outputs; how do the programmes meet the performance competencies and provide the required personal competence? This must be considered in context of the modern society and technology, taking advantage of the positives, while mitigating the negatives.

When considering technology in MET it is important to make the distinction between technology as a tool, as opposed to a change in the delivery strategy due to technology [12 & 13]. The latter will create a new model, while the former is just tinkering around at the edges. MET providers need to look to other compatible industries and learn from their achievements.

It is important to recognise the different needs of the individual learner and provide pathways for their success. Technology plays a major part in the younger generations and should thus be used to engage them with the curriculum, rather than looking upon it as a hindrance or a threat.

Most of MET is driven by STCW, but Goldberg [16] suggests "there is another training component which is largely unregulated and only minimally specified, but

is arguably just as important to safe operations: vessel-specific training. This is the training required for safe operations given the unique combination of vessel characteristics, layout, equipment, routines, routes and corporate policies of the vessel operator. Vessel-specific training has always been critical to safe operations, but in recent years has grown much more so in light of the continuously increasing sophistication and complexity of modern vessel-based systems. To make matters worse, simply knowing how to operate these sophisticated systems is not sufficient. A deeper understanding is required in order to facilitate intelligent problem solving when the systems are not behaving as expected or, worse yet, when interactions between multiple sophisticated on-board systems produce unexpected behaviours. Crews must be armed with the knowledge necessary to make an informed analysis and arrive at a logical decision.

There has been some recognition of this problem by the STCW. The best example is recent regulatory change for ECDIS training. ECDIS machines are essentially little computers and training is required in order to understand how to operate them correctly. This training is now mandatory. But why do the regulations stop there? ECDIS machines are not the only sophisticated systems on board - far from it.

Douglas [17] takes another view and states "The minimum safety standards required by IMO and national certifying bodies are no longer appropriate in the fast-moving and technological driven work environment of the seafarer. A good starting point would be to establish industry standards of competence covering all the actions and behaviors". He further suggests that "DNV has been doing this for years in its SEASKILL projects and has established over 20 such standards" [18].

Again, this leads to the view that STCW will need to be strengthened to reflect the way in which the use of technology can enhance the effectiveness of shipboard operations and MET. This needs to occur so that seafarers receive the education and training they need rather than what a dated convention currently prescribes.

4. CONCLUSIONS

The evidence for these points of view is found in many guises. Talk to students and serving seafarers; follow and participate in the lively online debates, e.g. Maritime Professional, Linked In and the Nautical Institute. This may well convince you that considerable changes are needed to make effective use of technology aboard ship.

The STCW Convention was written in 1978 and has been revised seven times in the ensuing period [19]. The last major revision was in 1995, some eighteen years ago, and although the 2010 Manila Amendments attempted to update the convention, it is evident that shipboard technology and its use moves far faster than the process of updating STCW.

It is postulated that a fundamental review is needed to clearly identify the competencies and attributes required by the seafarers of today and the future, so that ships can be effectively and safely operated. Identification of the skills needed to operate shipboard equipment and specific vessel types, as well as generic skills forms a framework for such a review. The results of a comprehensive review should allow for the revision of the certificate of competency structure and more appropriate on board organisational structures. But, most importantly, it should allow MET to become far more flexible, adopt modern pedagogical practices and technology, and provide what is wanted, when it is wanted, where it is wanted and how it is wanted.

A further consideration is that MET needs to be more proactive in its use of technology if the effectiveness of teaching and learning is to improve. Changes to STCW are clearly needed and MET institutions have the means to influence these changes. Both IAMU and Global MET have observer status at IMO, which presents the opportunity to take a lead in the much needed debate for change. But, is IAMU willing and able to take a proactive role in leading the much needed debate on the many challenges facing MET?

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