The Challenges of the Digital Technology Era for Maritime Education and Training

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The so-called fourth industrial or digital revolution is characterized by the unification of technologies that breaks the boundaries between physical, digital, and biological disciplines. Compared to three previous industrial revolutions the main differences of fourth are speed, extent and systemic impact. Only jobs that cannot be done by machines will last for the people in future; they will base on creative expression, social interaction, physical dexterity, empathy, ingenuity and collaboration [1]. Are the current education systems and paradigms oriented towards these values and goals? It does not always seem to be so. Mostly still leading a 20th century educational model introduces standardized facts and procedures designed to prepare the workforce for jobs that probably may not exist for a long time; this is not enough to cope with future challenges. The author raises some questions regarding the future education in general and for seafarers in particular. How to be more flexible and responsive to rapid changes? What is the new principles of education in the dynamically developing shipping industry and digital world where all information is available to everyone anytime? How to keep pace with the rapid and extensive changes in industries, including shipping? Lifelong inclusive and equitable education, formal and informal, physical and digital will be vital for the preparation of new populations and society to be successful in this unpredictable future.

Keywords— flexibility, rapid response, educational blocks, lecturer as a learner

I. INTRODUCTION

The fourth industrial revolution (fourth IR) makes it an unprecedented way for us to live, work and even treat each other. It is characterized by the unification of technologies that break the boundaries between the physical, digital and biological worlds. The three main differences between the fourth and previous three industrial revolutions are speed, scope and systemic impact. Compared to earlier industrial revolutions, the fourth is developing exponentially rather than linearly [2].

Education has a key role to play in meeting the challenges of the digital world, and maritime education is no exception. The development of so-called smart shipping in the near future will mean that investments in education and new type skills will be as important as technology itself, perhaps even more important.

The fourth industrial revolution - the digital revolution - should not be defined in the maritime sector solely through technology. Rather, it should also promote education and training to alleviate poverty and disseminate knowledge as a basis for sustainable global trade [1]. Undoubtedly, shipping is one of the cornerstones of global trade. What is "sustainable global trade" is, of course, question on its own. Who can answer this question today? Is the current global trade model sustainable? All the signs indicate that it may not be in the end. Does the fourth IR make this model more sustainable or, in opposite, make things worse?

The purpose of the author of this article is not to seek answers to global economic and social issues. By realizing that the robust and fast digitalisation of shipping in the coming years is inevitable, the author is trying to analyse whether the current education system for seafarers is ready to face new challenges, or at least moves (or is about to move) in the right direction for their changes? The author is convinced that without finding the right answers to this question and taking the appropriate steps, "smart shipping" can rather amplify current problems than mitigate them, or even create new ones.

II. THE NEED TO CHANGE THE PARADIGM OF HIGHER EDUCATION

All kinds of training, instruction and education in general have been simultaneously the derivative and the promoter of development for all four industrial revolutions (IR). The current fourth IR is a digital revolution and is significantly different from the previous three [2]. At the same time, the common overall objective of all four IRs is to produce more and to consume more; that means an incessant economic growth paradigm. Whether and to what extent this economic paradigm itself is sustainable is a matter of its own; its analysis does not fall within the scope of this article.

Every IR is characterized by fact that the educational paradigms and systems were forced to adapt to the innovations and challenges that each IR brought along, and with the demands that each IR presented to humanity as a whole as well as to each individual. Due to the inertia inherent in the education systems, this adaptation and the arrival of innovations always took a lot of time and required great effort, usually through disputes and old and new confrontations. One of the very important differences between the first three IRs and the fourth IR is that the processes of the first three IRs went on with tolerable speed and there was more or less enough time for changes. In such cases, education could be made more relevant and satisfactory to meet the challenges of the new era. The fourth IR key phrase is "no time". Perhaps there is not enough time, even to understand what is happening, the more that will happen in the future, not to mention that find and implement paradigms and policies that adequately respond to these challenges, including in education.

The first, and to a large extent the second and third IRs demanded an increasingly narrow workforce specialization, eventually starting not only for vocational but also for other levels of education, up to doctoral studies. At the same time, it can be said that not only in production but in the education of all levels as well, the principle of mass production began to dominate: mass production requires good specialists, but
they do not need to know much about anything that is not directly related to their professional activities. Since the number and variety of products and services produced had grown enormously during the 20th century, the number of specializations (curricula in education) also increased vigorously, with the maximum standardization of learning within each curriculum. It means that all learners in the curriculum predominantly study the same subjects that should lead that the final product entering the labour market should also be more or less similar. Fortunately, this is not always the case, because the basic material, or people, is different, how much the primary, secondary and high school education would not try to compensate for these differences.

In general, two main education systems are existing today; vocational education and higher or academic education. The main principle of first one has not changed much over the centuries; it is based on the principle of “doing as me”. Let us leave the VET system out of the debate, perhaps just mentioning that in the context of the rapidly developing fourth IR, the modern VET system cannot continue to be the same, i.e. it is forced to look for its specific niches and change its learning and teaching principles.

The system of higher education is also a victim of these economic paradigms, i.e. mass production, mass consumption and market economy principles. It is also characterized by narrow specialization. The current system of higher education is still largely orientated towards the production of nuts for a stable working system, rather than a ready-made for challenges creative persons. The model of an individual's education and working life cycle is essentially the following: 15 to 20 years of study, mostly with a growing specialization (they name it “investment in the future”), and after all the rest of the working life, this investment is capitalized, as a rule of the same field of activity (learned specialty). The author dares to argue that this system has become inadequate and no longer meets today's challenges; however, cosmetic changes are not enough for the system, and it requires fundamental or paradigm changes.

The 20th century educational model, which still maintains the leading position in many higher education institutions, introduces standardized facts and procedures designed to prepare the workforce for specific jobs. It can be assumed that some or even many of these jobs are unlikely to exist in the near future; this model generally does not provide sufficient or correct knowledge and skills to deal with future challenges. The jobs of the future are the ones where the machines cannot handle; these are jobs based on creative expression, social interaction, exclusive physical skills, empathy, ingenuity and collaboration [1].

III. TODAY’S CHALLENGES IN MARITIME EDUCATION

Future educated maritime workers are characterized by the following key words: diversity, personal achievements, social values and preparedness for future challenges [1]. Are the current education systems and paradigms oriented towards these values and goals? It looks like it is not always. Narrow specialization vs. diversity, system service vs. personal achievements, escape to social networking vs. prioritizing social values, inert and rigid education system vs. flexibility and preparedness for challenges.

The Estonian Maritime Sector Labour Force Survey report, which was completed in 2015, reflects the views and expectations of employers in the maritime sector [3]. These assessments have been obtained from interviews with representatives of companies, professional associations and governmental institutions. In the field of shipping, along with the need for good practical training, the importance of the general competencies of employees such as quick learning ability and independence, good communication skills and teamwork skills were also emphasized. Employers understand that the development of general competencies needs to be continuously addressed, for example by providing in-service training in management. They found that there would certainly be more need to promote entrepreneurship training in Estonian maritime education, especially in higher education [4].

Although entrepreneurs are “on two feet on the ground” and many of them are mainly dealing with running problems, a lot of them realize that the world is changing and with it, the workers must change. The managers of the maritime shore companies also found teamwork skills important for workers in the port and other maritime industries; ICT competences are becoming increasingly important in port work, as technological advances entail the digitalisation of information exchange (paperless economy) and port automation (pre-booking systems, car detection cameras, automatic gate opening systems, development of container terminals, etc.).

In order to see what should change in maritime education so that the persons acquired it can successfully cope in the new world of digitized maritime and shipping, we will ask ourselves two questions and try to answer them to the extent that it succeeds. Author informs that the following assessments base mostly on his personal experience and may not fully reflect the truth about some other universities or other educational institutions.

Question 1: What and how to teach?

The process of creating, approving, and launching new curricula, modules, subjects is now long, cumbersome and unable to respond quickly to increasingly rapid changes. Even the renewal of an existing curriculum may take a year, or even more, creating new curricula may be even longer and more cumbersome and bureaucratic. These new curricula or their innovations may already be outdated when start working.

Starting studying in the curriculum, the learner is obliged to go through it as it was at the time of admission. Nothing can be changed significantly during the course of studies, it means up to five years in addition to the two that took the curriculum creation and launch, many changes and developments in field are likely have taken place during this time.

How to make the learning process and curricula more flexible and responsive to rapid changes? In recent years, the author's university has taken the direction to unifying curricula and subjects, one expression of which is, for example, the equalization of all subjects; when it comes to a specific case, it is 6.0 ECTS. There is no rational explanation of why the size of all subjects should be exactly 6.0 ECTS. It may be supposed that it is more convenient to administer curricula with unified subjects. In the author's opinion, it
rather than teaching, or at least such learning and development. Developing of them is a question of breeding innate and children have all the prerequisites for their university with subjects? It seems that these qualities are essential to the entrepreneur may be provided by the course, good idea, but again, there are a number of questions. Does initiative ability, risk tolerance, and other qualities related to environmental and nature protection issues. The overwhelming majority of people, including the heads of large and not so large companies, and their employees know that things in this area are not to praise. They know about drastic climate changes, and that these changes will soon be irreversible, if not already, etc. They even agree that something has to be done and acting in these directions must be stronger. What do they do next? In their work, such as the management of an international shipping company or even in their daily activities, they continue with the same wasteful and self-destructive way of life and work that eventually leads to disaster. Why? Then they do not know how to, or are unable to, establish relationships between what they do in their home yard or in their company every day, and what is happening in the world.

One of the reasons for this may be that people learn things separately without definite and logical connection between them. Each university curriculum has subjects related to environmental and nature issues and protection, but often they are not directly related to others, especially specialty subjects; the students themselves are unable or unwilling to create these connections. However, since there are no fields, subjects, themes that are not related to the issues of protecting the environment today, the next scheme would be proposed for the 6.0 ECTS specialty subjects.

All specialty subjects could be structured according to the same scheme, i.e. divided into several parts. For example, this subject would have 2.0 ECTS subject-specific professional knowledge and skills, 2.0 ECTS would be related to environmental issues, and 2.0 ECTS would be ICT part. At the same time, these three parts must not be autonomous, or separated from each other, but must intertwine well and mutually support each other during the teaching of the subject. Of course, the distribution of ECTSs can be another, e.g. 4.0, 1.0 and 1.0, but the principle would remain the same. There may also be more of these parts, such as adding another 1.0 ECTS section to social relationships etc. Such a complex subject may have one teacher, but it seems more logical that there are several lecturers, each one of the specialists in one of these fields and they work closely together in teaching the subject.

Another example is business-related subjects in curricula. The goal of involving all students in business learning is, of course, good idea, but again, there are a number of questions. Does initiative ability, risk tolerance, and other qualities essential to the entrepreneur may be provided by the university with subjects? It seems that these qualities are innate and children have all the prerequisites for their development. Developing of them is a question of breeding rather than teaching, or at least such learning and encouragement must be done much earlier, starting from primary school if not from kindergarten. However, if the primary, secondary and high schools have succeeded in stifling these assumptions, there is nothing more to do by the university.

The problem mentioned earlier is still relevant for entrepreneurship studies, too. Entrepreneurship is learned as something separate, again without being associated with nature, society and the rest of the world. There are two postulates inherent in a market economy: a) the most important thing is to ensure economic growth, be it at the global, European, national or company level, and b) the main (if not the only) business goal is to make a profit. Both postulates are right from the point of view of the prevailing market economy model but is doubtful in nature from common sense; thanks to them, we have reached where we are now. Therefore, in teaching entrepreneurship, it would be necessary to apply the same complex principle. One part of subject is dedicated to business as such; the other part shows the damage that business can cause to nature and, more generally, to mankind, and shows how to prevent or at least mitigate those damages; third part deals with social relationships, communication skills, good relationships with other members of society, etc. None of them is on their own; all these parts are closely intertwined and supporting each other.

The guiding principle behind these proposals is that we have all reached such a situation when there is not enough knowledge of one or another narrow profession, or being an excellent specialist in field. It is very important to see the big picture, to create wider relationships and to foresee the consequences that one or another professional activity can bring not only to the person himself but also to his children, grandchildren, and ultimately to humanity as a whole in the future. Without it, no any technology will help us, how modern and digital it would be.

How to keep up with the rapid and extensive changes that occur in the economy and life at all, including shipping? Should the centre of gravity of the learning process shift to what we now call in-service training, i.e. the core of the curriculum should be flexible and constantly changing courses (also may be called “blocks”, can also be “modules” as is customary now)? During the studies, the learner must have the opportunity to change his / her priorities and to make new combinations of any of these “blocks” (except, of course, the major part of the course, the successful completion of which is a mandatory condition). One part of the curriculum must be focused on the so-called eternal values that give the ability to behave correctly and live in harmony with nature and society. Obtaining a graduation certificate is no longer end goal that has been achieved, but rather an intermediate step, followed by new and new trainings and innovations. Lifelong inclusive and equal quality education; formal and informal, physical and digital will be vital to preparing our population and society to succeed in this uncertain future.

Question 2: Who are teachers?

Acquired knowledge and practical skills are aging rapidly today; a seafarer who has completed his seafaring career ten years ago or more, and who has been a lecturer, may prove to be lagging behind some of his students in some areas. In the dynamically developing shipping sector and in the digital
world, in a situation where all knowledge is in principle accessible to everyone, the professors / former masters are no longer the ones with the exclusive knowledge and skills. They could be rather the ones who can give advice on how usefully to use the information available and talk about their own experiences (some of which may constantly change ineligible).

In the times of the previous IRs, the educational paradigm was currently characterized mainly by the teaching principle "Do as I do, I teach you how to do", which is still the basis for vocational education today. Nowadays, the principle of teaching "I tell you what I know and show you what I can do - you try to do better than me" has replaced it mainly in higher education. It seems that the principle of teaching in future may be "Let’s learning together, thinking together and finding the best solutions”.

The principle of complex subjects described above presents the special requirements to teachers. Applying this scheme requires a very good cooperation ability of teachers, both among themselves and with students. The common part of the study is then conducted in the form of discussions and disutations. The so-called project training is very well suited, where lecturers from different fields prepare and launch projects that require complex solutions from students. Of course, in the digital age teaching staff have to be very good at using modern technologies in teaching.

IV. SMART SHIPPING AND PECULIARITIES OF SHIP OFFICER TRAINING

In one of his publications, the author of this article gives an overview of both the positive and the negative sides of the so-called smart shipping [5]. Under smart shipping, the author is considering such a common system where ships and ports are connected to one global system and operated in the most optimal way using common algorithms. These systems require full or large-scale integration of intelligent ships and smart ports into a single network leading by so-called artificial intelligence.

In the author's opinion, the concept of fully autonomous or 100% of travel time independent ships is unsustainable (except for short and under very certain conditions' trips) because of the excessive risks that the author describes in his article [5]. Even for the fully autonomous ship, the possibility of intervention by the shore operator must be maintained. Consequently, we can only talk about remote-controlled vessels, which differ in how much of the ship's activity is driven independently by the ship itself or centralized artificial intelligence, and how much of the time by human intelligence, meaning the appropriate operator.

What's more, the author of article shows that fully autonomous merchant ships that do not have crewmembers on board during the entire journey may not be the best and most effective solution, especially when talking about ocean transports, mainly because of the risks arising from number of external and internal factors that can damage or even paralyze the system. The author describes radical changes that may accompany the digitalisation of the ship, including possible new schemes for crewing of ships [5].

It seems to the author that for a smart shipping, the optimal ship would be an intermediate variant of a fully manned and autonomous ship, the so-called semi-autonomy ship [5]. There may be two possible solutions here.

The conditional name of the first solution may be 3M (three masters) and it is the most suitable for use on deep-sea lines. For every single ship, this means that it should have at least three people on board throughout the voyage, who keep watch on board like usually, but will not interfere in the normal operation of the ship as an autonomous unit. At the same time, they are always aware of the situation and are able to assess the situation and the need for intervention. If such a need arises, for example in an emergency, they will take control of the ship. This means, among other things, that these people are excellent ICT specialists, at the same time well trained, and experienced seafarers (with the captains' qualifications). It is because “three masters” [5].

The second solution for semi-autonomy ship is called MP (master-pilot) and it would be a part-time vessel manning. This option would be better suited for shorter lines and feeder line services conditions. In general, ship sails as autonomous between pilot stations on port of departure and port of arrival. During this time, there are no crewmembers on board of ship. Upon arrival at the boundary of pilotage or high-risk traffic areas, a person who can be called master and pilot simultaneously, arrives on board and takes over the control over ship. It does not necessarily mean that he will immediately intervene in the process of navigating the ship, but he is ready to do it at any moment. The master-pilot will remain responsible for the ship throughout her stay in the port and will take part in the departure of the vessel from the port and pilotage area. This person must also have good ICT education and excellence knowledge, skills and experience in seafaring that means ship master level.

Accordingly, the training of seafarers must become two-fold. The first step is like today training in accordance with the STCW Convention and may be correspond to the level of bachelor or applied higher education. To become a captain, as it is now, they must acquire practical seafaring experience and meet the qualification criteria.

Becoming a captain or a chief mate on a ship, they have the choice to continue at sea or to move into the world of autonomous and remote controlled ships. They can become smart ship operators, but some of them can go to the next level to acquire the knowledge and qualifications of the above-mentioned 3M captain or master-pilot (let us name them as extra-masters). This level of training generally corresponds to modern university Master's studies and the most part of it is specific ICT training specified to shipping and ship management; the other parts of studies dedicated to personal development and to learner’s horizons widening and intellectual developing. The master obtaining this education must be able to "communicate” with artificial intelligence, always understand what is going on and be able to intervene when necessary, and achieve positive results in difficult situations at sea.

In this way there will form a layer of "sea elite" (in the good sense of this expression). They will be very highly demanded and highly paid workers in shipping. This is understandable because from their qualifications, judgment, experience and much more will depend the preservation of very high values and the prevention of the worst scenarios at sea.

Finally, the author wants to introduce idea about some new type of simulation training, which he calls on-site simulation. At the moment, a thorough practical training on
bridge, machine and other simulators is a mandatory part of the training of ship officers, and this is, of course, very correct and necessary, but there is one very important drawback to these exercises - they are not real. Today's simulators and their software have attained a very high level of reliability and proximity to real situations, but - every learner can even subconsciously realize that what would not happen on the simulator screen, it has not actually happened, and in the worst case ends with a sniff of a nervous laughter.

For comparison, let us bring a car driver learner who only studies on a driving simulator. If at one point he or she does not sit in the car and does not start to move around the city, he or she probably never becomes a good driver.

Of course, the introduction of simulators for the training of ship officers is perfectly understandable. There is no point in risking the ship and perhaps even human lives by creating dangerous situations on a real merchant ship or a training vessel to learn to cope with such situations and successfully exit them. After all, the ship is not a car and the risks are too high.

Nonetheless, digital technologies and the coming of intelligent ships on the seas offer new solutions in this area. Namely, connecting a number of ships, both manned and remotely controlled, and a number of training schools to one network, in case of a sufficient number of objects, occasionally something will happen from time to time with vessels - sometimes not very serious, but sometimes it can be quite complicated and dangerous. Today's (and more so tomorrow's) technologies provide an opportunity to be virtually on the scene for the number of learners who can not only monitor what is happening and how the other people get out of the situation, but also by operator's command to deal with situations and provide solutions. The big advantage of such an on-site simulation is that everything happens in real life, and the consequences of the wrong decision can be not only the screeching sound and the blind simulator screen, but also the real damage.

REFERENCES


