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EDUCATING THE FUTURE MARITIME WORKFORCE IN A SEA OF CONSTANT DISRUPTERS AND CHANGE

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Abstract. This paper considers how technological change, and the rate of that change, will impact maritime education and training and our graduates. Changes in technology, the environment, the regulatory picture and globalization represent a more complex array of forces for our students to understand than ever before. Students can no longer assume that acquired technical skills will serve the demands of their rapidly changing workplaces. These changes and challenges require maritime universities to elevate our academic programs, ensure our curricula remain relevant, and provide our students with tools and adaptive skill sets they will need to become life-long learners. This will require maritime universities to conduct an "environmental scan" of the world and environments in which they operate, and interpret relevant external factors and trends. As an example, the author provides a scan of the maritime industry, its impact on maritime education and training programs, and recommendations on how maritime universities can adapt in an age of "accelerated change."

1 INTRODUCTION

Today, technology and globalization are driving the greatest changes in the maritime industry since the shift from sails to steam over 150 years ago. Disruptors include: digitization and data analytics; systems integration and automation; e-commerce; new technologies; and, environmental regulations. These same forces are affecting every sector of the maritime industry for which we prepare students, as well as the world of higher education.

How is the challenge of constant change for the current and future generations of students and mariners different from that of previous generations? I believe New York Times columnist and best-selling author Thomas Friedman describes it best in his book *Thank You for Being Late: An Optimist's guide to Thriving in the Age of Accelerations*. Friedman says it is the dizzy pace of simultaneous and accelerating change in three different but interconnected realms: the market; Mother Nature; and Moore's law [1]. The market refers to globalization which is causing the world to be "hyper-connected" and more interdependent. Mother Nature is climate change, biodiversity loss, and population growth. Moore's law states that the power of microchips will double every 24 months. The impact of these interconnected realms is that technological change is accelerating so fast that, unlike in the past, people, regulations,

and educational institutions can no longer keep pace. We are now in what Freidman refers to as the "age of accelerations" [1**].**

2 EDUCATING THE MARITIME WORKFORCE IN THE "AGE OF ACCELERATIONS"

Given we are in a new age of accelerations, how do we graduate students who have the adaptive skills and tools necessary to succeed in the industries of today and the future? Changes in technology, the environment, the regulatory picture and globalization represent a more complex array of forces for our students to understand than ever before. Students can no longer assume that technical skills they acquire at the university will serve the demands of a rapidly changing world. More than ever, students need to learn the flexibility, adaptability and entrepreneurship that will prepare them for changes to the maritime industry in which they will work and for many different jobs they are likely to hold. This means our institutions must graduate students who can adapt, retool, and re-learn throughout their careers. In other words, they must be life-long learners.

We can only do this through a balance of education and training. Education provides the theoretical foundation and promotes intellectual and personal growth in areas such as: critical thinking and analysis; quantitative and scientific reasoning; information literacy; communication skills; leadership and ethics; appreciation for global civilizations and the natural world; and competency in a field of study. Training refers to skills and knowledge that relate to specific useful competencies. Training prepares students for a current job, while education prepares them for a career.

Our students and graduates must have access to education and training that is relevant. Our institutions must have processes in place that, through meaningful partnerships with the industries we serve, ensure our courses and programs are germane. We have been familiar for decades with the term "just in time logistics". We must now adapt this same concept to our institutions and offer "just in time education and training." However, we must do more than just react to accelerating changes we must anticipate them. Our institutions must be more agile. Supporting Friedman's concept of accelerating change, Eric "Astro" Teller, Chief Executive Officer (CEO) of Google's X research and development suggests that today with shorter and shorter innovation cycles and less and less time to adapt, "the time of static stability has passed us by...the new type of stability is dynamic stability." He likens this to riding a bicycle, "where you cannot stand still, but once you are moving it is actually easier" [1]. This might be easy to say, but how do we do this when it comes to maritime training and education? How do we learn to operate in an environment of "dynamic stability?" First, we must know where we are going on the bicycle. We must anticipate future trends and the impacts of those trends.

3 ENVIRONMENTAL SCAN: ANTICIPATING FUTURE TRENDS AND IMPACTS

A useful tool for anticipating future trends and impacts is an "environmental scan." This process systematically surveys and interprets relevant data to identify external opportunities and threats. Typically, institutions and organizations conduct an environmental scan as part

of a five to ten year strategic plan. However, in a world of accelerating change, scanning must be a continuous process that enables us to anticipate and react to change.

In undertaking an environmental scan, maritime universities must identify the various environments that may impact them and define the period of time the scan will consider. While it is important to define a period for the scan (5, 10, 15 years), in some cases real change that will affect our students and future graduates may be outside the selected period. However, these changes may start to demonstrate emergence within the period of the scan.

For example, while most industry experts agree that ships and our logistic systems will become increasingly automated and integrated, completely autonomous ships and ports may not emerge on a large scale for decades. However, systems onboard current vessels and new builds will become increasingly automated, integrated, and in some cases autonomous. Therefore, while we may not set up a program for an autonomous mariner license today, we must infuse new technologies and technical fluency across the curriculum so our graduates can operate in a more integrated and autonomous environment.

What common environments or areas should a scan for maritime universities consider? In preparation for State University of New York (SUNY) Maritime College's new strategic plan, we looked at six areas: world trends; technology; energy; maritime industry; higher education; and the area of maritime education and training. While these may be common areas for all IAMU members, the implications of the scan will differ for each institution based on geography, political concerns, national regulations, economic considerations, unique institution missions and considerations, and regional competitors. The scope of this paper will be limited to the scan of maritime industry and its impact on maritime education and training. However, as the aforementioned environmental areas are inter-related, we will include the relevant trends and impacts from the other environmental areas especially as they relate to maritime industry over the next decade

4 MARITIME INDUSTRY TRENDS AND IMPACTS ON EDUCATION AND TRAINING

The integration of digital technologies into everyday life – digitalization – is reshaping every aspect of our lives and business. The development of sensor technologies and smart technologies will continue to accelerate. Just look at the how our automobiles have become mobile data vacuums that can track everything from the weight of the passengers, to what we listen, to whom we call, to diagnostic information. Machine learning is being incorporated into everyday technologies. Along with these advances, data analytics by sophisticated computers and programs will enable the development of autonomous systems that are situationally aware, capable of making decisions and adept at learning. The connectivity of systems will improve with ubiquitous communications systems.

As such, there is consensus that there will be a steady progression to autonomous (i.e. self-learning, integrated intelligent) systems for ships with the goal of autonomous ships in the future. This will mean a reduction in crew sizes and a shift where licensed mariners are required in order to operate ships safely in autonomous and manual modes. A more digital and tech savvy crew and maritime workforce will be required onboard and ashore. The nature of licenses is expected to change with a demand for relevantly new licenses, such as the Electro Technical Officer credential, or new credentials for remote operation of ships.

Just like other industries where technology has eliminated jobs, the overall number of jobs for mariners could actually increase due to increased volumes of shipping traffic associated with an expected increase in world Gross Domestic Product (GDP). However, different skill sets and credentials will be associated with these new jobs. We need not fear automation. A Deloitte study of job automation by U.K. industries found that over a 15-year period 800,000 low-skilled jobs were eliminated as the result of artificial intelligence (AI) and other automation technologies, while 3.5 million new jobs were created. These new jobs paid on average $13,000 more per year than the ones that were lost. The study went on to conclude: "continued success will rest on the ability of businesses and organisations, educators and government to correctly anticipate future skills requirements and provide the right training and education" [2].

The ongoing transition from manual and automatic to autonomous systems over the next decade will result in increasingly complex systems. More integrated and complex cyber systems will require cyber resiliency against malicious or inadvertent attacks for all sectors of the maritime industry including ship and terminal operations, brokering, chartering, protection and indemnity (P&I), ship registry and supply chain management. Part of the solution to providing security for complex systems includes block-chain technology. Two years ago, not many people were talking about blockchain technology and were incorrectly assuming that it was the same thing as the crypto currency Bitcoin. After the June 2017 cyberattack that cost Maersk as much as $300 million and disrupted operations for 2 weeks, there was an accelerated interest in blockchain technology. IBM and AP Moller-Maersk set up a joint blockchain venture to make the company's supply chain more efficient and secure [3].

Cyber threats, and new technologies such as blockchain, will drive the need for a digital maritime workforce having new certificates/credentials. Anticipating this need, at SUNY Maritime College we recently incorporated a multi-discipline team-taught undergraduate cybersecurity course which involves five of our academic departments. For graduate students we are in the process of building a two course certificate program. These undergraduate and graduate courses focus on the cybersecurity threat in the maritime environment and include a familiarization with blockchain technology. But even before we were working to develop a formal curriculum to incorporate cybersecurity and blockchain into our curricula, our student computer club was already embracing this technology, participating in sponsored port hacking exercises and learning more about blockchain technology. I would suggest it is skills such as critical thinking and creativity, provided through a well-rounded education, which gave them the drive to explore and learn these new digital technologies even without a formal program in place.

Beyond technological changes, there are energy and environmental trends to consider. The world population is expected to grow from 7.5 billion in 2017 to 8.5 billion by 2030. Africa and Asia will experience the largest growth and comprise the largest percentage of the world population [4]. With this growth, it is estimated that 20% more energy will be consumed. Although fossil fuels will still be a significant part of the energy mix, natural gas and renewables will contribute more. Significant advances and reduced costs will occur in renewable energy technology such as wind, solar photovoltaic (PV) and ocean current/tidal energy. With an increase in offshore renewable energy in the next decade, a demand will arise for specialized workforce and ships to build and maintain offshore renewable energy platforms, mariners to operate those ships, and offshore energy technicians and renewable

energy plant operators. How are we as maritime universities prepared to meet this new workforce demand? SUNY Maritime College is the process of establishing an Off-Shore Renewable Energy Center of Excellence to partner with industry and establish new programs that will meet their future workforce requirements.

Shipping will become greener and more fuel-efficient. According to DNV GL, "the growth in liquid natural gas (LNG) powered ships is expected to accelerate towards 2025." In 2017, there were about 75 LNG powered ships in operation (excluding LNG carriers), and another 80 are under construction. Additionally, 40 ships have been designed to be ready for an LNG retrofit [5]. In response to the growth of LNG powered ships, SUNY Maritime is establishing an LNG Center of Excellence, with a similar purpose as the aforementioned off-shore center of excellence. Recent developments in ship propulsion electrification, new battery storage technologies and hybrid-electric solutions on smaller vessels could be the harbinger for some degree of hybridization on larger vessels in the next decade. Sources estimate that by 2025 a majority of larger vessels could have some degree of hybridization [5]

As with all technological changes, views vary on the rate of the adoption. Automated ships and ports require a large capital investment. With the surplus of tonnage on the market today, this could slow new capital investment in more automated or autonomous ships. International Standards of Training, Certification, and Watching-Keeping (STCW), and national laws and regulations which are based on those standards, will need to be changed to permit crew reduction sizes associated with more automated or autonomous operation. There is a reluctance of ship and terminal owners to "be the first" before regulations have fully evolved and industry standards have been defined/adopted. The same is true of ships with newer types of propulsion. On the shore side, labor unions will continue to slow the adoption of automation, due to the potential loss of jobs for their members.

5 CONCLUSION: WE NEED TO CHANGE COURSE

So how do we respond as maritime universities to this sea of constant disruptors and change? First, we need to conduct consistent and meaningful assessment of our academic and training programs to ensure quality and relevance. Given that technology is advancing at an exponential rate and outstripping current workforce capability, our environmental scan and assessment of current programs need to help us anticipate required changes in our curricula and develop new credentials/certifications that will be required by the maritime industry. This will necessitate:

- faculty capable of integrating technology into the classroom;
- close partnerships with industry;
- applied learning opportunities and internships that introduce students to the latest technology;
- similarly, more opportunities for faculty-industry interactions; and
- increased faculty-student research opportunities.

Relevance will also require our program and course review processes to change. While shared governance is essential, the process of revising and updating curricula must move from static stability to dynamic stability. As the rate of technological change increases, we must establish new processes that enable us to evolve, change, and deliver "just-in-time" programs

and courses.

In order to adopt this model, we will need to frequently scan the horizon, determine what DVG-GL refers to as the most probable future, and understand that while there will be significant uncertainties, we should be able to make decisions, and equally important assess them, based on current trends in a relatively short period [5].

For example, Google needed a course after they released basic algorithms for an open source program called TensorFlow in October 2015. Udacity, working directly with Google engineers, was able to develop and put online a course by January 2016. Friedman calls this "jump starting the curriculum." Traditional universities would find this nearly impossible under current academic structures[1]. In short, our institutions need to become more agile.

Second, our students will also need to become more agile. We must identify the current and future adaptive skillsets necessary for our graduates to succeed in the job market of today and thrive in the industries of tomorrow. This will required us to carefully balance and integrate education and training, infusing these important themes and skillsets across our curricula. In short, we must integrate knowledge in a discipline (major), hands-on learning experiences, and adaptive skills from across a program of studies in liberal arts and Science Technology Engineering and Math (STEM) disciplines. In this way, we will provide graduates not only immediate employability in a competitive career field but also the character, adaptability and ingenuity to succeed throughout their careers as the nature of the industry changes rapidly[WM1].

Finally, recognizing the maritime industry is a global industry there must be closer and more frequent collaboration among IAMU institutions. Our students and faculty need to be more aware of the geo-political, international, and economic factors that drive the maritime industry. This will require increased opportunities for study abroad, international internships, and faculty exchanges.

There will be inertia internally and externally to these needed changes. However, not to acknowledge that change is required will not serve our students or the maritime industry well.

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