# Maritime Industry 2030

## A Summary of Discussions with Industry on Joint Challenges and Opportunities

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# MARITIME INDUSTRY 2030

## CBS MARITIME

A SUMMARY OF DISCUSSIONS WITH INDUSTRY ON JOINT CHALLENGES AND OPPORTUNITIES

CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

**ABOUT THE CONFERNCE AND THE MARITIME RESEARCH ALLIANCE**

In addressing the challenges ahead for the maritime industry, we need to look through more than the one pair of research spectacles! This is the message from the OECD, academia, industry, from NGO´s as well as from a broad range of maritime organizations, when discussing the future challenges and opportunities of the maritime industry.
In other words, a singular focus, either from a health, technical, economic, social or regulatory perspective, is not fulfilling the need for research-based answers to the challenges and opportunities regarding the future of the maritime industry.
On the other hand the path forward requires interdisciplinary knowledge production and analyzing the problems from different angles as complex challenges, most often, require complex and multifaceted solutions.
In an attempt to answer the call for enhanced interdisciplinary maritime research, seven Danish universities, all engaged in maritime and ocean research and education, joined forces to initiate a collaboration named "Maritime Research Alliance".
The alliance has participation of researchers from Aalborg University, Aarhus University, Technical University of Denmark, Copenhagen Business School, University of Copenhagen, Roskilde University and The University of Southern Denmark as well as from two Danish maritime professional academies, SIMAC and MARTEC.

The focus of Maritime Research Alliance is to:

- Initiate interdisciplinary research projects that address challenges related to digital and sustainable ocean economy and governance
- Establish an organizational platform of maritime and ocean experts within different areas of expertise
- Create awareness around Danish maritime and ocean research and education
- Be an entry point for collaboration for industry as well as international universities and organizations
- Market the Maritime Research Alliance as a partner in relation to new research initiatives – national and international

The inauguration of this new university partnership was in the form of the conference named "Maritime Industry 2030" held at Copenhagen Business School in 2018. The following report sums up the outputs of a two-day event, in the form of a conference and a researcher's workshop. The conference was kindly supported by the Danish Maritime Fund. In 2020 the fund supported the establishment of the alliance based on, among other, future cross-disciplinary research themes and ideas that were identified at the conference.

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# INTRODUCTION

THIS REPORT SUMMARIZES THE DISCUSSIONS AT THE MARITIME INDUSTRY 2030 CONFERENCE AND BROADER IMPORTANT MARITIME INDUSTRY ISSUES AS WELL AS PRESENTS THE GOALS OF **MARITIME RESEARCH ALLIANCE** – A COOPERATION BETWEEN SEVEN UNIVERSITIES AND TWO DANISH MARITIME PROFESSIONAL ACADEMIES.

"The Maritime Industry 2030" was the kick-off conference for the Maritime Research Alliance (MRA), which was recently established in cooperation between seven Danish universities and two Danish maritime professional academies. This report summarizes the discussions at the conference and broader important maritime industry issues as well as presents the goals of MRA.

The "Maritime Industry 2030" conference was an international and joint researcher/practitioner event held at the Copenhagen Business School during 5-6 February 2018. The first day of the conference was an open event organized with the aim of bringing industry and academia together to identify and discuss the most important issues facing the maritime industry in the near term towards 2030 and to lay a firm foundation for closer cross-disciplinary collaboration for addressing these issues. The second day of the conference was a closed event for MRA members organized with the aim to reflect on the identified issues, determine the future focus and direction of MRA and initiate specific collaborative research projects.

There have been several calls from private foundations, industry associations and governmental agencies to map out and to extensively coordinate cross-disciplinary maritime research in Denmark. MRA is an initiative that strengthens existing and creates new collaborative relationships across the universities and maritime academies, in part as a response to such calls. The most important aims of MRA are to:

1. Find solutions to those challenges to the maritime sector that require cross-disciplinary ventures
2. Create a critical mass of expertise in Denmark for maritime and related topics
3. Be a visible and viable one-point-of-contact to academic involvement and output for the industry
4. Attract attention nationally and internationally for Danish maritime research and education
5. Make Danish universities and maritime academies attractive partners for international cooperation on maritime and related projects

Overall, MRA aims to develop solutions to the grand and complex challenges for maritime companies and organizations and for society more broadly, such as, value creation, employment, climate change and environment, safety and health. MRA will engage in multi-disciplinary as well as inter-disciplinary collaborative research projects as well as in collaborative educational activities.

The macro view presented in the next section provides a broad review of the most pressing challenges and issues facing the maritime industry over the medium to long term, as these have been conceived by major industry and societal stakeholders (in Denmark and internationally) and laid out in policy recommendations, industry strategies, government reports and other publicly available sources. The macro review is intended to be comprehensive, and it provides a rather broader review of maritime industry challenges than those issue areas that were covered during the MRA kick-off conference. Indeed, the issue areas chosen for the conference (Digitalization, Autonomous ships, and Decarbonization) were selected from our evaluation of the importance of topics addressed openly by

policymakers and other key decision-makers and presented in the macro review.

The following section summarizes the kick-off conference. The selected issues addressed at the conference included Digitalization, Autonomous ships, and Decarbonization and a sustainable ocean economy. For each of these three areas we start with a short review of the most important challenges and issues and then summarize the presentations. In addition to covering these three areas, the first day of the conference included a session on industry-university collaboration, as experienced with the establishment of the Danish Hydrocarbon Research and Technology Centre.

The last section is concerned with the set-up of MRA and possible research collaborations. We discuss in particular different forms of research collaboration, interdisciplinary and multidisciplinary research with special emphasis on cross-functional team collaboration and the important facilitator role of an appointed research coordinator.

***Maritime Industry 2030 conference participants***
*Photo: Bjarke MacCharthy*

# MACRO VIEW

EVER-GROWING COMPLEXITY IN THE CHALLENGES AND ISSUES FACED BY THE MARITIME INDUSTRY AND INCREASING PRESSURE FROM STAKEHOLDERS ARE REQUIRING THE INDUSTRY TO ACT ON SOME OF THE ISSUES.

We see ever-growing complexity in the challenges and issues faced by the maritime industry and increasing pressure from stakeholders requiring the industry to act on some of the issues. This section provides an overview of the most important challenges that the maritime industry currently faces, as recognized in various policy papers, consulting reports and stakeholder declarations. Some of the issues identified in reports of different international, national or industry organizations were selected for deeper discussion during "The Maritime Industry 2030" conference at CBS, while others were not. All challenges and issues summarized in the present section, however, require cross-disciplinary research, development and innovation carried out in collaboration between industry and academia.

## REPORTS

The below depiction of industry challenges and issues relies on the following key reports. The OECD has contributed with two important publications: "The Ocean Economy in 2030" (OECD, 2016a) focuses on the future of the so-called ocean economy on a very comprehensive scale. It reports from on a three-year research project and aims to combine the cross-disciplinary knowledge with the in-depth insights from specialized workshops. This report is one of the most recent and most extensive reports about the future of the ocean economy. The other important publication "The Future of the Ocean Economy" (OECD, 2014) focuses on the contribution of the ocean economy to the overall economy.

In "Report on the Blue Growth Strategy" the European Commission presents policy recommendations to spur innovation and economic growth within the ocean economy, but also to assure improvements in ocean health and sustainability of the ocean economy.

The Danish Maritime Forum, which was held in Copenhagen in 2015, gathered over 200 maritime industry professionals from all over the world. The ensuing report "Navigating Challenging Waters" discusses the presentations, workshops and inputs from the different conference participants and provides a very good overview of the perceptions on different challenges and issues within the industry.

We also discuss the "Recommendations" from the Maritime Strategy Team established by the former Danish government in May 2016. In 2017, the team presented 52 specific policy recommendations with the aim to assure and strengthen the competitive edge of the Danish maritime sector (also known as "The Blue Denmark").

In addition to the above, we refer to a range of other reports and recommendations. We will not discuss these in greater detail, but a summary of findings is included in the appendix at the end of this report

## DIGITALIZATION

Digitalization has caused major changes in various industries. The possible applications are diverse and can be advantageous for all kinds of companies, also in the maritime industry. Digitalization is possible due to

technological advances, and further advances will cause automation of more and more processes. As a result, there is the potential to increase the efficiency of operations tremendously. Therefore, the Maritime Strategy Team (2017) recommends promoting digitalization within the maritime sector in Denmark to increase efficiency. These efficiency gains in turn are supposed to ensure the competitiveness of the Danish maritime sector. The strategy team also emphasizes promoting digitalization to give the Danish maritime industry a competitive edge. Additionally, they recommend the digitalization not only of companies, but also of governmental bodies – especially so as to streamlining communication between industry and regulatory agencies to enhance the efficiency and competitiveness of Danish companies. Ideally, European standards could be reached to reduce the administrative burden for all companies in Europe.

These recommendations of the strategy team mirror the concerns of the European Union (EU) as outlined in the Valletta Declaration, especially on the importance of digitalization to ensure efficiency gains. The declaration, which was adopted by the European Transport Ministers in March 2017, notes that the digitalization of all regulatory bodies should be continued to enforce the maximum efficiency gains possible from digitalization. Thereby, the European Union also wants to take the opportunity to cut Red Tape and simplify regulation, while making sure that the regulation is continuously updated to promote further use of digitalization. The latter task is difficult because of the pace of digital change, as noted by the OECD (2016a).

The FORSK2025 (RESEARCH2025) catalogue published in Denmark by the Ministry of Higher Education and Science shows the most important research areas of the future as seen from the perspectives of Danish businesses, organisations, ministries, knowledge institutions and a wide variety of other stakeholders. The FORSK2025 catalogue mentions another important advantage of the application of digitalization. Through digitalization and more efficient transport and logistic systems, it would become easier to achieve sustainability goals for business, e.g., along the lines of the United Nation's requirements to achieving the so-called Sustainable Development Goals (SDGs) before 2030. Although there have been some promising attempts already to increase the digitalization within the industry[1], the maritime industry is overall still very fragmented, which hinders to unleash its full potential. Potential ways to realize the efficiency gains were discussed during "The Maritime Industry 2030" conference.

The Hamburg Port Authority and the Frauenhofer Center for Maritime Logistics and Services CML (2017) outline the necessary steps for successful digitalization:

1. Digitize analog data
2. Digitize analog processes
3. Link system with processes
4. Develop digital business models

Unfortunately, many companies fail to implement the first step to digitize the data, which is crucial to transform the business to a digital business. The OECD (2016a) notes that inadequate data or lack of data is currently a major problem, even though the necessary infrastructure already exists, but also that regulators improve statistical and methodological base at national and international levels to measure the performance of ocean-based industries and their contribution to the overall economy. Based on these findings, regulation could increase its efficiency, since the basis on which their decisions are made would be significantly increased. To achieve these benefits, the Valletta Declaration calls for the better use of data and encourages data sharing. Additionally, the OECD (2016a) points out that machine learning and data analytics will be major drivers of innovation in the maritime industry.

Overall, the maritime industry should overcome its fragmented and conservative nature to develop a common vision and enable increased innovation (Danish Maritime Forum, 2015). Several of the presentations given at the "Maritime Industry 2030" conference focused on this aspect and their solutions will be presented later.

Innovation and entrepreneurship are also major topics within the maritime industry. The Maritime Strategy Team (2017) highlights the importance of innovation to ensure the competitiveness of the Danish maritime sector. In particular, they recommend setting up regulation in such a way that maritime start-ups will not face major challenges with administrative or regulatory tasks, especially data driven tasks. Furthermore, the strategy team believes there are ample opportunities for developing new business

[1] The global network of Smart Ports aims to optimize maritime logistics by sharing good innovation practices within the network (Hamburg Port Authority & Frauenhofer Center for Maritime Logistics and Services CML, 2017)

models within the maritime sector, and the importance of unlocking the potential of entrepreneurship to achieve strong business models. More broadly, the Maritime Strategy Team (2017) highlights the importance of innovation in the maritime sector as one of the main factors for the continued success of the industry in the future.

the sector. Additionally, the European Commission (2017) proposed to strengthen the employment of more women thus increasing the diversity of the sector as well as the size of the overall talent pool.

However, not only the attractiveness for young people is an issue in the maritime sector, but also the training of talent. The Maritime Strategy Team (2017) recommends

***Conference break out session***
*Photo: Bjarke MacCarthy*

## EDUCATION AND TRAINING

Closely connected to the issue of entrepreneurship is the attraction and education of talent. The European Commission (2017) suggests measures to making the sector more attractive to young talent, especially for sea-side employment and career development. Seafarers usually stay several month onboard ships and away from home, and given the high attractiveness of other sectors, many young people thus decide to pursue their career outside the maritime sector, even if they were initially interested. In particular, the European Commission (2017) recommends to improve social life onboard for the seafarers in general and improve also other measures (e.g., onboard internet access) to increase the attractiveness of

up-to-date training and a higher international cooperation to implement such training facilities with the goal to strengthen the Danish maritime sector. The Danish Maritime Forum (2015) also expressed the need for training to ensure the current competitive edge.

Besides from the importance of training people within the industry there is a recognized need for educating the broader population as well as build up research capacity to enable a viable maritime economy especially in the less developed parts of the world. The OECD (2016b) delivers a good example of this issue in their “Towards a Blue Economy: A Promise for Sustainable Growth in the Caribbean” report. The report was written in concern of the poor sustainability performance in the Caribbean

maritime sector despite the good environmental premises. One of the main factors for the poor performance was the fact that the population was not sufficiently educated about the problems of their unsustainable behavior, such as, extensive fishing. The Caribbean population must be further educated about the ocean as an ecological system, which serves as the underlying asset to all maritime economic activity and will deteriorate if extensively used. Additionally, the OECD (2016b) recommends supporting this development with further research to ensure exploration of further sustainable economic possibilities in the blue economy, which is also often specific to the area. Similar views have been uttered for other less developed regions of the world, such as the vast and resource-rich, but endangered Indian Ocean Rim (Doyle, 2018) or the South Pacific Ocean (Keen et al., 2018).

## AUTONOMOUS VESSELS

Training becomes even more important when considering the increasingly rapid technological changes already taking place within and outside of the maritime sector. Maritime companies must strengthen corporate entrepreneurship and innovation to survive and potentially grow. This becomes even more pronounced as technological and scientific progress around autonomous vessels is likely to dramatically change the required skills and competencies within the industry (Lloyd's et al., 2017). Even though the most likely scenario is that autonomous vessels coexist with nowadays vessels (Hamburg Port Authority & Frauenhofer Center for Maritime Logistics and Services CML, 2017) autonomous vessels and remotely controlled vessels are expected within foreseeable future to change the landscape of the industry significantly. The shipping industry is one of the first industries that will adopt remote operations and autonomous vessels since predictability of the environment of the ship is relatively easy compared to other means of transportation (DNV GL, 2016). Predictions as to when autonomous vessels will enter the shipping industry vary, but the challenges for a market entrance are well defined (Lloyd's et al., 2017):

1. Development, validation and application
2. Integration with existing assets
3. Associated risk, dependability/reliability
4. Affordability (in terms of return on investment)
5. Regulation and legal challenges

However, when these challenges are overcome, the economic gains from autonomous and/or remotely controlled vessels are tremendous. Remotely controlled ships can be designed to have more cargo capacity, while reducing at the same time the wind resistance as a deck house, accommodation and catering for the crew are not needed anymore (Levander, 2017). Another advantage of not having crew onboard is that piracy is no longer a threat. Even if pirates enter the ship, they cannot take hostages or control over the ship, making the capture of the ship uninteresting (Levander, 2017). Moreover, remotely controlled ships will also have several effects on the labor force in the shipping industry. Firstly, the attractiveness increases as seafarers can work on land close to their home and do not have to spend several months onboard, away from their family and friends. Secondly, other skills are needed as the development, integration and controlling of the autonomous vessels become the focus, while the actual number of ship officers is likely to decrease as it is possible that one captain can control several remotely controlled vessels through a station on shore (Levander, 2017). Such a station could broadcast the situation on several ships to one place on shore from which the captain can take action if required. Additionally, if the reliability of autonomous vessels can be increased sufficiently, it is possible to reduce the number of accidents since the majority of accidents today happen because of human error (Levander, 2017).

As already noted, there are several and not-so-trivial challenges to be solved to implement autonomous ships. However, the OECD (2016) notes that innovation and actual construction of autonomous ships provide major strategic competition and growth opportunities particularly to the shipbuilding and marine equipment industries.

Overall, the potential economic advantages of autonomous shipping are tremendous and are likely to be gained within the next decades. The recommendations from policymakers and other key stakeholders focus very much on the engineering side of innovation and urge companies to take this development into account already now to build and sustain their competitiveness.

## DECARBONIZATION

It is a startling fact that the international shipping emits more nitrogen oxides (NOx) and sulfur oxides (SOx) than even big economies such as India, Russia or the United States, causing serious health damage to humans. Shipping is also accountable to some 2-3% of global CO2 emissions and hence is responsible for a significant part of climate

change (global warming and ocean acidification). The economic potential of the ocean economy is hence threatened by environmental and climate change. The threats have several aspects, which we will discuss, but the same logic applies to all of them. The OECD (2016a) recognizes this idea in the blue economy concept: The ecological system serves as the underlying capital asset to all ocean-based economic activity. The capital can be depreciated due to economic activity. Following economic theory, a smaller capital stock means lower returns and less economic activity in the future. A clear tradeoff emerges: How much economic activity are we willing to give up today to save the ocean environment and to have more economic activity in the future?

Current maritime economic activity is substantial. The OECD (2016a) estimates the Ocean's economic contribution very conservatively at USD 1.5 trillion or 2.5% of today's world gross value added (GVA) with roughly 31 million full-time jobs (about one percent of the total global work force). Also, the projections for a "business-as-usual" scenario indicate a growing impact of the Ocean economy to the global economy, with more than three trillion USD to global value added and 40 million full-time jobs in 2030. Overall, the ocean economy has the potential to outperform the average world economic growth and make an important contribution to employment growth, according to the OECD (2016a).

However, the negative environmental impact of the maritime industry is also substantial. Various studies have shown that around 2-3% of total global emissions of CO2, 5-10% of total global emissions of SOx, and 17-31% of global total emissions of NOx can be attributed to the shipping industry, and both the EU and the OECD have voiced their expectations that the air emissions from shipping will double or maybe triple towards 2050. A series of greenhouse gas (GHG) studies commissioned by the International Maritime Organization (Skjølsvik et al., 2000; Buhaug et al., 2009; Smith et al., 2014; Faber et al., 2020) have led to policies setting targets for the maximum allowed emissions of sulfur as well as promoting the reduction of shipping emissions through energy efficiency. The most recent GHG strategy of the IMO sets very ambitious targets for the reduction of CO2 emissions from shipping.[2] The CO2 emissions from shipping and other ocean activities also contribute to intensifying ocean acidification, which in turn weakens animals and corals living in the ocean.

Overall, the environmental and climate impact of shipping and other ocean activities will likely have a significant negative effect on future economic activity, according to the OECD (2016a). Noone et al. (2012) estimate the total economic damage due to climate change in their high impact scenario at a staggering USD 428.1 billion until 2050 and USD 1,979.6 billion until 2100.

As a result, extensive economic use has clearly already depreciated the ocean's health. The Danish Maritime Forum formulated the ambition to cut the environmental impact from shipping in half, while at the same time increasing growth and profits. Partly, companies have also realized the future burden of climate change and increasingly aim to reduce GHG emissions – indeed, some front-runner shipping companies have expressed an aim for zero carbon shipping by 2050, which means that zero carbon ships have to sail the oceans and seas already from 2030.

We present now several aspects, which have the potential to make the ocean economy more sustainable and therefore yield more economic activity also in the future.

[2] The initial IMO GHG strategy adopted in April 2018 aims to reduce CO2 emissions from ships per transport work by at least 40% by 2030 compared to 2008 and pursues efforts towards 70% reduction by 2050. It also sets the overall target of reducing total annual GHG emissions from international shipping by at least 50% by 2050 compared to 2008.

### Alternative Fuels

As already discussed, the emissions of the shipping industry are substantial. Even though ocean shipping is already the most efficient way to transport goods, emissions are high and the efficiency leaves room for improvement (DNV GL, 2016). As a result, various sources state the need for lower emissions, which will eventually be enforced by regulation. The global sulfur regulation decided by the IMO has been effective since 1st January this year and limits the sulfur content of marine fuels to 0.5% (down from 3.5%) (DNV GL, 2018). This target can be reached either by changing to low-sulfur (alternative) marine fuels, or by installing marine scrubbers systems onboard the ships to remove sulfur from the exhaust gases generated from the combustion processes in the ships' engines. Today, more than 4.000 ships have scrubbers installed.

The IMO's most recent greenhouse gas study (IMO, 2020) not only revealed a close to 10% increase in greenhouse gas emissions from ships in the period from 2012 to 2018, in spite of various innovations to increase the energy efficiency of ships, but also that such improvements in energy efficiency have slowed down since 2015. While the development of alternative, climate-friendly marine fuels have been on the industry wish-list for many years now, there is increasing awareness that further improvements in energy efficiency are limited and that zero carbon ships must be realized by changing to alternative marine fuels and developing the engines to burn them.

Liquified natural gas (LNG) has been and still is considered a particularly interesting alternative to existing marine fuels, because it is relatively cheap and widely available and emits considerably less SOx, NOx and particulate matter (PM) when compared to conventional oil-based marine fuels. The EU, following recommendations in European Commission (2017), among other reports, encourages the development of alternative fuels to limit both greenhouse gasses and local air pollutants (in particular, NOx and SOx) and actively promotes the building of LNG bunkering facilities. LNG bunkering facilities have extended quite rapidly in recent years (DNV GL, 2018). Large European ports such as Port of Antwerp and Port of Rotterdam provide LNG bunker permits and incentivize shipowners to use LNG as a marine fuel. Russia is also betting on LNG as the essential marine fuel of the future. However, LNG is still a fossil fuel and today the focus is gradually changing to cleaner alternatives such as green ammonia and renewable hydrogen as well as methane, the latter of which is cost-efficient, in abundant supply and require relatively modest fuel conversions of the ships. Most of the potential alternative marine fuels (e.g., biofuels) require considerable innovations in the techniques to produce them as well as in engine technologies and ship design.

### Fishing

Fisheries is one of the industries that will notice the impact of climate change the most, because the fish stock depends on a healthy and productive ecosystem (OECD, 2014). With an increasing effect of climate change, the oceans will become warmer, have less ice, a rising sea level and less biodiversity. This will result in a significant effect on the fish stock composition (OECD, 2016a). The fishing stock also shows signs of overfishing, e.g., in the Caribbean, because efforts have increased steadily, but total catch of fish is stagnating (OECD, 2016b). This problem is amplified by unreported and unregulated fishing, where no clear solution to this big problem is in sight. As a result, growth expectations in this sector are rather small.

From the argumentation above, it appears likely that supply of catch fish at best will remain similar to today's level, but demand is expected to grow. As a result, aquaculture has the opportunity to close the demand gap (OECD, 2014) and marine aquaculture is expected to have a particularly strong growth rate in the future (OECD, 2016a). However, there are also limits to the growth of aquaculture production: availability of suited water, packed coastal line with other economic activities, insufficient nutrition, or extensive water pollution and stronger regulatory pressure (OECD, 2014).

All in all, the supply side is likely to struggle to keep up with the increase on the demand side, resulting in price increases. Furthermore, the regulatory enforcement of fishing quotas remains a substantial problem for the worldwide fish stock.

### Ocean Monitoring

As we have shown in the section before, undeclared and unreported fishing is one of the main problems for sustainable fishing. The main problem to prevent unreported fishing is the inability to detect and punish

unreported fishing (OECD, 2014). Therefore, ocean surveillance and the enforcement of regulation could become an important foundation to tackle this problem. However, ocean monitoring also has other advantages besides the detection of unreported fishing: Overall, the scientific understanding of the ocean would increase. Additionally, more ocean resources could be identified. Another important aspect is the understanding of the interdependencies within the ocean economy, which are also a key characteristic to the ocean economy (OECD, 2016a). Thus, the understanding of the influence of the ocean economy on the ocean is an important aspect of ocean monitoring (OECD, 2014).

Yet, ocean monitoring is a difficult and expensive task and no country is by itself able to perform the task. Therefore, greater international cooperation is needed to share the burden of ocean monitoring and to realize the potential gains from it (OECD, 2014). It is also worth mentioning that the process of data sharing in this aspect can be improved to create a better data basis for the regulator in general (OECD, 2014).

### Ocean Acidification

One aspect where the ocean monitoring struggles to evaluate the economic value of the data produced is the area of ocean acidification (OECD, 2016a).

Ocean acidification is happening due to climate change. As carbon emissions have increased, the ocean has increasingly absorbed the carbon, leading to an acidification of the oceans (OECD, 2016a). The effects of this acidification on the ocean and the ocean economy are various: The migration patterns of fish change and some fish stocks even become extinct. Acidification also leads to less biodiversity, as corals are abundant. Therefore, not only the ocean itself is hurt, but also the ocean economy. From the symptoms above, it comes as no surprise that fisheries and marine aquaculture have the highest burden caused by ocean acidification. The estimates for the economic loss through ocean acidification go up to over USD 100 billion (Narita et al., 2012). Overall, this problem can only be solved through a dramatic reduction in carbon emissions (from ships as well as from shore-based industries and households), which in turn will stop ocean acidification.

### Offshore Power

The expansion of renewable energy is one possible way to fight climate change. Offshore power based on renewable energy today has relatively small capacities, but the long-term potential is tremendous. Offshore wind accounts for less than 1% of the value added of ocean-based industries but is projected by the OECD (2016a) to increase to 8% by 2030 in the business-as-usual scenario. Offshore wind power has a huge economic potential but will also benefit from government subsidy to reduce production and running cost. Further growth drivers are potentially cost saving and efficiency gains along the supply chain. The OECD (2016a) projects considerable expansion in the installed capacities for wind energy and also expects massive job creation in this sector. In the long run, the OECD (2014) predicts installed capacities as high as 175 GW by 2035. However, there also challenges that need to be solved to realize the potential gains. The problems are of technological, regulatory and supply chain nature. As offshore is moving further offshore into deep waters, it becomes increasingly complex to construct windmills, which imposes a technological challenge to the offshore wind industry. Additionally, the limit of maritime space, planning restrictions, competition with other ocean activities and international boundary issues impose regulatory challenges. Furthermore, the supply chain might limit expansion due to shortage of high voltage sub-sea cables and offshore construction vessels (OECD, 2014). Offshore wind is not the only offshore power generation possibility: Tidal barrages are also advanced, while tidal and ocean currents as well as wave power are not yet at demonstration stage (OECD, 2014).

Overall, the long run potential of offshore renewable energy is tremendous, but it requires immense investments and innovation in new production and distribution technology and the underlying organization and regulation.

# CONFERENCE TAKEAWAYS

# CONFERENCE: THE MARITIME INDUSTRY 2030

## THIS SECTION GIVES AN OVERVIEW OF THE CHALLENGES AND ISSUES DISCUSSED DURING THE CONFERENCE.

While most of these issues were already summarized in the previous section, the following section describes the personal opinions of key experts who were invited to speak at the conference, and possibly some solutions.

**"Global Trends and Future Perspectives on World Trade"**
*by Christopher Rex, Head of Research, Danish Ship Finance*

Christopher Rex is the Head of Research at Danish Ship Finance in Copenhagen and leads the company's team of experts, who on a daily basis gain analytical insigh into the world of shipping. He and his team of economists are across not only the global trends, but also the technology trends which are in many cases driving them. Christopher Rex has more than 14 years of experience in the banking industry and holds Master's degrees from Renmin University of China and Copenhagen Business School.

In his keynote presentation, Christopher Rex outlined the factors that Danish Ship Finance believes will drive the international shipping industry in the future. In particular, he focused on the challenges to justify his rather pessimistic forecast, but he also offered possible solutions to the challenges in the industry. Christopher Rex predicts that the volumes shipped per dollar growth will reduce and that the long-term growth of seaborne trade will hover around 1%. If true, this would be significantly lower than the 2-3% annual growth rates predicted by other analysts. The main drivers for his prediction were:

- Demographics: The population in industrialized countries is aging. Retired people usually consume less, so the demand overall will reduce.
- Technology: Renewable energy becomes cheaper and more useable. In the long run, fossil fuel will be substituted and therefore less transportation of fossil fuels is needed.
- Robot Tech: Factories might get relocated due to robot technology, artificial intelligence and 3D printing. Therefore, products might get produced closer to the consumers and products do not need to be shipped.

Consumer Preferences: People become increasingly aware of the negative aspects of shipped products (e.g., air emissions) and will shift towards more environmentally friendly products.

***Christopher Rex, Head of Research, Danish Ship Finance***
*Photo: Bjarke MacCarthy*

The supply side also indicates challenges for the future within the shipping industry. The fleet is relatively young and the order books are full, so the current overcapacity in

the industry is likely to remain for considerable time. Additionally, the fleets get demolished earlier, which reduces the economic value of ships.

Overall, both the demand and the supply situation appear challenging. However, Christopher Rex also indicated a potential way for companies to improve their future outlook. The shipping industry is a service industry and therefore "significantly enhanced value propositions for customers" are needed and so there is great potential for developing new business models. Shipping data could be monetarized and a marketplace for anonymized shipping data could be created. Furthermore, performance management and capacity optimization could increase the efficiency of the current operations, while extending the operating model towards more service orientation, and value creation beyond the vessel could create new income streams for the future.

**"Opportunities and Challenges and Cross-Disciplinary Research"**
*by Lars Jensen, CEO and Partner, Seaintel*

Lars Jensen has over 16 years of experience of working inside the container shipping industry. Since 2011, he has acted as an independent strategic analyst, advisor and thought leader in the container shipping industry. In his recent book, "Liner Shipping 2025", Lars Jensen points to how the core business models and business cultures that made the international container shipping lines successful, are now failing, and how the coming decade will see the emergence of new business models suited for a new environment. He holds a PhD and a Masters' degree in Physics from the University of Copenhagen.

In his presentation at "The Maritime Industry 2030" conference, Lars Jensen elaborated on the challenges and opportunities that technological transformation imposes on the shipping industry. In his opinion, such transformation will come at a much slower speed than may be anticipated. The long lifespan of assets in the shipping industry will make physical trade difficult to disrupt.

He believes that it is not technology and its development, but rather the transformation of the whole ecosystem that poses a challenge. As an example, he references the Bill of lading from 1978 that is still in place in the shipping industry. The bill of lading is outdated and does prevent a more efficient way to work in the industry. This example represents a problem that exists in the whole industry: Everybody must work together, but everybody uses old and inefficient ways to handle things. Alternatively, they use different systems, which are not compatible with each other. These inefficiencies result in losses for the whole industry. As a result, Lars Jensen calls for more cooperation as automatization will come anyway. Differentiation in the future will not happen through automatization, but through how companies handle exceptions.

Additionally, the transparency in the industry has increased in the past and is likely to increase also in the future. Therefore, Lars Jensen recommends that the industry embraces transparency and builds a strategy around full transparency scenarios, rather than trying to prevent transparency. Overall, Lars Jensen calls for a mentality change in the industry towards a more collaborative environment rather than a fragmented environment.

Research has the potential to gain understanding of the problems and can find solutions. Lars Jensen especially highlighted the following areas as main problems for the industry right now opening up for both academic research and incremental and radical innovation possibilities for entrepreneurial companies: poor core data, human-machine interface, high degree of non-conformance to plan, advanced modelling in the face of extreme fragmentation in yield management, and fleet deployment

***Lars Jensen, CEO and Partner, Seaintel***
*Photo: Bjarke MacCarthy*

# MAJOR CHALLENGES FOR THE MARITIME SECTOR MOVING TOWARDS 2030

## DIGITALIZATION

- Technological advances enable digitalization
- Tremendous potential for efficiency gains
- Digitalization of authorities also important
- Regulation has to react
- Companies struggle to digitize data

Technological progress gives the maritime industry the opportunity to digitalize their business. The possible applications are numerous and various, resulting in the potential for tremendous efficiency gains. These efficiency gains are possible since decisions can now be made automatically, interactions do not to be bilateral, but with a central platform, to just name two important applications. Therefore, several public advisory teams recommend promoting digitalization (Maritime Strategy Team, 2017).

Another important issue to maximize the efficiency gains is the digitalization of governmental bodies and public administration, which is likely to make interaction with the companies easier and more efficient. In the process of digitalizing government bodies, there is also the opportunity to continuously update and simplify the regulation, as also noted by the OECD (20126a). The goal would be to encourage companies to digitalize and maximize the efficiency gains from digitalization. Regulation could also benefit from digitalization as more data would become available. As a result, regulators can ideally make better decisions as the data basis for the decisions is improved (OECD, 2016).

Unfortunately, the most advantages are yet to realize as the maritime industry struggles to digitalize their business model. In particular, the digitalization of analog data currently represents one of the absolutely biggest problems (OECD, 2016a).

Two presentations at the conference were focused on topic of digitalization and how companies can profit from digitalization. The goal was to offer solutions to the problems laid out above. Maersk Line's Ingrid Uppelschoten-Snelderwaard focused in her presentation on the digitalization of Mærsk, while DFDS' Anneli Bartholdy highlighted the importance of digitalization to achieve a sustainable business model.

### "How Shipping Can and Will Increase Efficiency Across International Supply Chains"

*by Ingrid Uppelschoeten-Snelderwaard, Global Head of Equipment, Mærsk Line*

Ingrid Uppelschoten-Snelderwaard was appointed Global Head of Equipment in Maersk Line in January 2016. She is responsible for in-fleeting and out-fleeting, Remote Container Management (RCM), equipment maintenance and repair and container sales. She started her career in the Maersk Group in 2001 as a Commercial Line Manager for Safmarine. She then joined Sealand in 2005, and a year after, she joined Maersk Line as Route Manager for the Middle East. She has a broad shipping experience and has held positions in the Netherlands, Namibia, Tanzania and Poland.


***Ingrid Uppelschoeten-Snelderwaard, Global Head of Equipment, Mærsk Line***
*Photo: Bjarke MacCarthy*

The logistics and transport market is currently in the early stages of digital transformation. Up until now, the sector has provided simple solutions to the complex supply chain needs of its customers. However, these simple solutions lead to inefficiencies as well as a bad customer experience. As a result, the sector started to change and digitalize its business models.

Ingrid Uppelschoten-Snelderwaard specified how Maersk aims to become the leading global integrator of logistics. In particular, Maersk Line wants to focus on services to become the one-stop-shop in the logistics sector. Thereby, Maersk plans to lead the sector in improving the customer experience and enable its customers the next level of operation optimization. To achieve the ambitious goals, Ingrid Uppelschoten-Snelderwaard pointed out two solutions. Firstly, she presented the joint IBM/Maersk Line Global Trade Digitization (GTD) blockchain platform to reduce the administrative paperwork that traditionally leads to massive inefficiencies in the industry. As part of the digitalization process of the company, Maersk Line had analyzed the administrative burdens to ship avocados from Mombasa to Rotterdam. In total, 30 actors, 100 people and 200 information exchanges were required for this rather simple task. Based on the research of Maersk, Ingrid Uppelschoten-Snelderwaard provided estimates of a global saving potential of $27 billion. The platform's main advantage would be that everybody interacts with the platform instead of interacting with several counterparties. Thus, the overall amount of interaction can be reduced as well as the time period needed for an answer. However, there are several challenges to be solved to achieve the projected efficiency gains: All involved parties have to be integrated to one system. The whole ecosystem of the logistics sector has to be changed, which is a challenging task. Additionally, the platform has to be very precise about what information it shares with whom. The GTD platform has subsequently evolved into the TradeLens platform, which over the past two years has attracted many users from the international shipping, trade and logistics sector and is now settling as an industry-wide, global blockchain platform for transparent trading and document management.

The other possible solution to implement digital solutions to improve customer experience, presented by Ingrid Uppelschoten-Snelderwaard is the Remote Container Management (RCM) system, personalized through the robot assistant Captain Peter. This system gives the customer access to much more data about his or her container shipment. For example, the customer can track the GPD of a container through satellite, as well as see the CO2, O2 or humidity level that the container is currently in. The idea is to enhance the customer satisfaction through more information availability. Additionally, it gives the customer cargo flexibility as he can change the route of his container fast, allowing thereby the customer a fast reaction to changes circumstances. Moreover, the whole supply chain of the customers can be visualized, giving the customer a better overview.

Overall, digitalization has the potential to tremendously increase the efficiency in the transport and logistics sector. The successful digitalization efforts of Maersk Line are illustrative of the potential as well as the challenges that must be overcome, and they are part of more general industry shift.

## "Industrial to Digital: The Future of Sustainable Business Models"

*by Anneli Bartholdy, Head of Innovation, DFDS*

At the time of the conference, Anneli Bartholdy was Head of Innovation in the integrated shipping and logistics company DFDS, based in Copenhagen. Over the past decade she has been involved with and led organizational change and innovation activities mostly in roles within the Maersk group as well as SingularityU Denmark. Some of the main activities she has been involved with include R&D portfolio building and management, ideation and crowdsourcing campaigns, startup strategy development and scouting, and digital business transformation and new business designs. Anneli Bartholdy has a Master's degree in Leadership and Innovation from Aarhus University.

***Anneli Bartholdy, Head of Innovation, DFDS***
*Photo: Bjarke MacCarthy[Caption]*

In her purposefully advocating presentation at "The Maritime Industry 2030" conference, Anneli Bartholdy used the 6 D's Framework of Technology Disruption (Digitize, Deceptive, Disruptive, Demonetize, Dematerialize, Democratize), developed by Singularity University, to explain the challenges of developing sustainability-led business model innovation in DFDS

She emphasized the importance of working with a cross-functional innovation team to focus on what the customers' needs are, and that they do not define the team or the work based on technical considerations only. She explained that when setting a new direction for your company, it is really something new and it is important that you get various departments to work together and. That you establish a proper timeline for the innovation team to identify business opportunities and turning them into new business model concepts.

# AUTONOMOUS SHIPS

# AUTONOMOUS SHIPS

- Massive reduction of labor cost is possible
- Different ship designs can potentially increase efficiency tremendously
- Reliability of technology is critical
- International legal framework is needed to further promote the right technology

The developments of remotely operated and autonomous ships will lead to significant changes in the shipping industry. Progress is happening so fast that some experts expect fully autonomous ships to enter the market already in 2025 (DNV GL, 2016). The advantages of remote vessels and autonomous ships are various, but the two most important advantages are labor cost reduction and more efficient ship designs:

Firstly, autonomous ships will reduce costs for labor enormously since autonomous ships need less personnel onboard or on shore. This incentive for the shipping industry to invest in research is additionally driven by the still existing global shortage of skilled seafaring labor, which drives up the salary in the sector. Therefore, autonomous ships will come first in operation in sectors where the share of labor cost is relatively high (Lloyd's et al., 2017). Potentially, the demand for skilled seafarers can be reduced, if a captain oversees several ships at the same time (Levander, 2017). A remote workplace for the captains will also increase the attractiveness to the shipping industry in the hunt for talents. Seafarers nowadays have to spend several months onboard, away from their family and friends. Remotely controlled ships would allow them to work on land, where they can just commute to work as if they have a usual office job.

Secondly, autonomous ships can have a more efficient design than today's ships, which will reduce costs tremendously. In the design for autonomous ships, the designer does not have to account for a crew and its accommodation. As a result, ships can be built in a way to reduce wind resistance and carry more freight instead of making room for the crew. Lower wind resistance will reduce cost and more fright will increase the revenue per ship (Levander, 2017).

However, the adoption of the new technology also requires improvements in the reliability. The reliability includes the accurate operation of sensors and satellites at all times, so that the ship can be remotely operated. Further progress must be made to make the technology marketable but DNV GL (2016), among others, have noted that there are already prototypes and that the technology would likely be ready for commercial use by 2025.

Another important criterium for the adoption of the new technology is the international legal framework. The rapid improvements in the technology imposes a challenge to the current legal framework as the latter has not kept up with the speed of the improvements. Therefore, parts of the technology might be adopted without having a proper legal framework. Critical questions in this area are for example: Who is paying for the damage caused by an autonomous ship? The ship owner, the software developer or the manufacturer of the sensors? Additionally, an international framework is needed, as ships usually operate between countries and different legal frameworks would further complicate and therefore hinder the new technology. It is obvious that further improvements in the legal area are needed to pave the way for the new technology (Lloyd's et al., 2017).

Autonomous vessels were addressed at "The Maritime Industry 2030" conference in two presentations. Oskar Levander focused his presentation on what the changes potentially will look like and how companies can quickly adapt. While the changes are certainly exciting, a legal framework is also required to promote investment and trust in the new technology. Lawyer Bjarke Holm focused his presentation on the current legal situation and possible solutions to regulatory questions of the future.

### "The Ship and the Future"

*by Oskar Levander, Senior Vice-President Concepts and Innovation, Rolls Royce Marine*

Oskar Levander joined Rolls-Royce in 2012 as Vice President of Innovation, Engineering & Technology, Marine and is today Senior Vice President of Concepts & Innovation, in the Digital & Systems value stream. Prior to this, he spent the majority of his career at Wärtsilä where he held various roles including Director, Concept Design, Marine Lifecycle Solutions. Oscar Levander has worked mostly with the development of new ship designs, machinery and propulsion concepts for various ship types and emerging marine technologies. He was included in "Lloyd's List 2011 One Hundred Most Influential People in the Shipping Industry" and in 2017 he was nominated as the #1 Technology Leader by Lloyds List. He graduated

with honors from Helsinki University of Technology in 2000, with a Master's degree in Naval Architecture.

***Oskar Levander, Senior Vice-President Concepts and Innovation, Rolls Royce Marine***
*Photo: Bjarke MacCarthy*

In his presentation at the conference, Oscar Levander highlighted that automatization and digitization are happening and will potentially disrupt the shipping industry. Therefore, he argued, companies should see this development as an opportunity to reduce costs rather than as a threat to their revenue. However, investments in improving the reliability of the systems – like sensors, redundancy and connection at all time – are required to achieve the reduction in cost. As a result, ship owners can save a lot of money since they need less personnel, the risk of accidents is reduced (once the systems are properly developed) and the ship design can be adjusted since the ship does not have to accommodate the crew (or at least a much smaller crew). As already noted, autonomous ships can be designed to minimize wind resistance just as they would no longer require safety systems for crew. All these developments can benefit the shipping industry when properly used. While such improvements seem desirable, the shipowners must invest before they can achieve cost reductions. Furthermore, the reliability of the sensors is critical to the speed and efficiency with which the new technology will disrupt the shipping industry. However, these are just temporary problems and in Oscar Levander's opinion automatization will come anyway: he predicted remotely operated local vessels by 2020, remotely controlled and autonomous offshore vessels by 2025 and autonomous ocean-going cargo vessels by 2030.

Additionally, Oscar Levander stressed the importance of an integrated supply chain and the huge opportunity for efficiency gains in this sector. He made the prediction that maritime supply chains will become more integrated, and that there will be increasing influence of the cargo owners. In his vision, cargo brokering will become more direct digital and removing middlemen, which will increase the profits for shipowners. However, to implement a more integrated supply chain, more cooperation between the companies is required to achieve the goal. A digital marketplace with an industry-wide acceptance would be a first step in this direction as it would reduce the total number of interactions needed. [3]

Overall, Oscar Levander appealed to the industry to change its mindset: In his view, more investments in future technologies are needed and a better cooperation between the companies will help their businesses and the shipping industry in the future.

### "Legal Obstacles and Hurdles for Autonomous Ships"

*by Bjarke Holm, Attorney and Partner, Core Law Firm*

Bjarke Holm Hansen is a specialist maritime lawyer and has worked as an advisor to the maritime, offshore and transportation industries throughout his career. He is co-founder and partner of CORE Law Firm, a specialist firm focusing on disruptive new technologies (e.g., Digitization, Connectivity, Autonomous vessels, 3D Printing, IoT and Big Data) within core industries such as maritime, offshore and wind. Bjarke Holm has a Master's degrees from the University of Aarhus and the Université de Cergy-Pontoise.

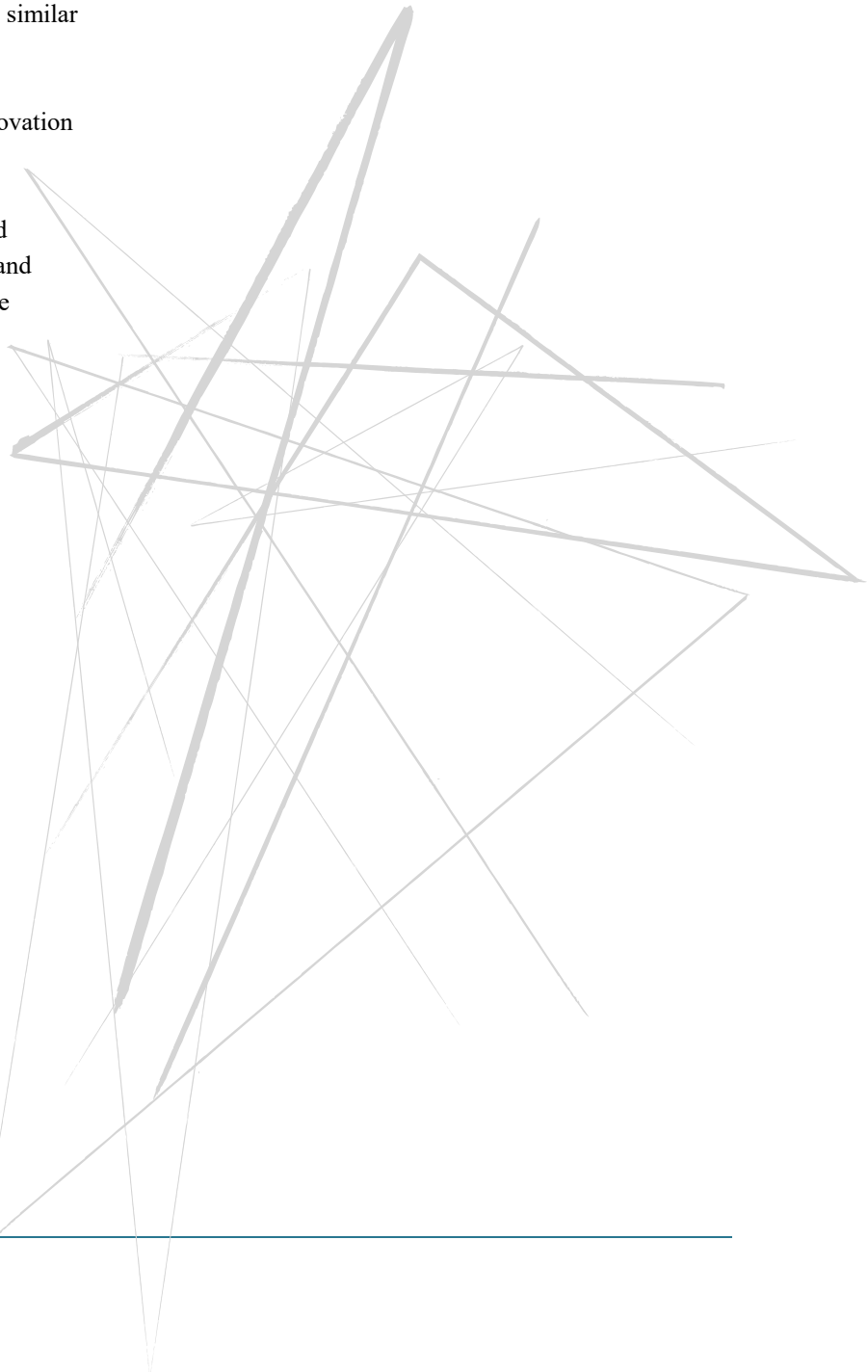
The potential economic gains from autonomous ships are tremendous. However, a proper legal framework is needed to realize the gains. Bjarke Holm focused his presentation on the findings of the report "Analysis of Regulatory Barriers to the Use of Autonomous Ships", on which he was one of the authors. He highlighted several legal questions that arise from autonomous ships. For example, determining who is liable for an accident with an autonomous ship is difficult as the causal link is more remote. Additionally, there is the problem of the corresponding jurisdiction. What is the obligation of the captain for remotely controlled ships? The main problem with the jurisdiction is that the commercial gains increase with automatization and with the remoteness of decision-

[3] As also discussed in the presentation by Ingrid Uppelschoeten-Snelderwaard

making but unfortunately, they also increase such legal issues as discussed above. However, the problems for the current regulation increase with the factors that also increase the commercial gains. Bjarke Holm also emphasized that regulation will need an interdisciplinary approach as the technical and legal details are too complex to be understood by an individual.

From the problems stated above, it becomes clear that an international legal framework is needed to solve these problems. Bjarke Holm introduced a conceptual framework for how regulation could be established. In his opinion, the IMO should complete a resolution first to avoid too many different initiatives at many places at one time, which could lead to an inefficient redundancy. The IMO should partner with technology providers to avoid over-implementation. However, countries can start regional or national tests to prepare national regulation and to provide an overview of required amendments. A similar process could be done on an EU level.

Overall, the speed of technological change and innovation in autonomous shipping is high and this imposes a challenge to regulation. However, an international framework started by a resolution of the IMO could unleash the full commercial use of the technology and potentially lead to significant efficiency gains in the industry.




# MARITIME INDUSTRY 2030

## DECARBONIZATION AND A SUSTAINABLE OCEAN ECONOMY

- International shipping is a major contributor to emissions of CO2, SOx and NOx
- Further tightening of regulation must be expected
- Companies start to push towards more sustainable business models
- Paradigm shift is happening: Ocean health is regarded as fundamental to the maritime industry
- Alternative fuels to reduce emission are explored

The impact of the maritime industry on the oceans and seas, and to climate change in general, is significant. Therefore, regulation will become tighter, but also companies have started to push towards more sustainable business models. However, a change in awareness for the maritime industry as a main contributor to the environmental and climate change is urgently needed, and emissions from shipping are massive and increasing. There is now concerted industry efforts and realization of a need to act. Particularly, the search for alternative fuels has moved center stage in maritime and environmental regulation, and it has also become a key focus for innovation in forward-looking companies. The main attractiveness for some alternative fuels steams from their low emissions, in particular the low CO2, NOx and SOx emissions from LNG (DNV GL, 2016). However, the adoption of LNG and other alternative fuels depends on various factors such as: gas price (which in turn depends on the oil price), technological advances and a tightening of regulation. Overall, alternative fuels are crucial for the future of the maritime industry as a sustainable business model depends on environmental friendliness.

A paradigm shift is essential to unleashing the enormous potential of the maritime industry. The OECD (2016a) introduced the idea that the oceans and seas provide the underlying asset to any maritime economic activity. According to this idea, environmental degradation (depreciation) of the oceans and seas (asset) will lead to less economic activity (lower returns). Therefore, the health of the oceans and seas is crucial to the future of the maritime industry. However, an ocean is a public good and economic theory tells us that public goods need the protection of regulation to maximize the value for society. Alas, the regulation of the oceans and seas is yet highly sectoral and fragmented (OECD, 2016a). Hence, we need further steps to implement effective regulation to protect the oceans and seas.

### "Implementing New Technologies and Business Models towards Energy Efficient Shipping"

*by Tristan Smith, Reader in Energy and Shipping, Bartlett School of Environment*

Dr. Tristan Smith is a Reader in Energy and Shipping at UCL-Energy and leads the UCL-Energy Shipping Group at The Bartlett School of Environment, Energy and Resources. His research focuses mainly on the development of techno-economic models for the shipping industry and the design of policy instruments for CO2 emissions reduction. He was the principal investigator on the Shipping in Changing Climates consortium that sought to understand and develop solutions for environmentally friendly, energy efficient and sustainable shipping, a member of the Carbon War Room Shipping Efficiency Advisory Board, and co-chair of the Carbon Pricing Leadership Coalition's Maritime Thread. Tristan Smith obtained his M.Sc. and PhD degrees from University College London and also has a Master of Arts from St. Johns College Cambridge.

In his presentation at "The Maritime Industry 2030" conference, Tristan Smith focused on the importance of alternative fuels and possible decarbonization pathways, to reduce the impact of the shipping industry on climate change. Alternative fuels become increasingly important as regulation tightens, reducing thereby the viability of traditional oil-based fuels. For example, the IMO expects some type of CO2 reduction systems in place by 2021. On this basis the questions arise: How fast does the technology change? What are the pathways? How do business models and research have to react to this?

The CO2 budget will determine how much CO2 needs to be saved. Based on several scenarios, Tristan Smith showed that in the long run the average carbon intensity of the world commercial fleet must decrease by 70-90%. In his baseline scenario of a Panamax Bulk Carrier, the best option is the maximum specification case with a 75% fuel carbon factor reduction, as it allows the ship to still travel at a fast speed while meeting the set CO2 emission goals. Additionally, Tristan Smith showed that renewables provide cheaper energy in the long run. The main cost components are extra capital machinery, capital storage, voyage cost and revenue loss. As a result, he advocates several policies, divided in public and private. The public

sector should focus on the following aspects: Energy efficiency standards (EEDI); operational efficiency standards; Monitoring, Reporting and Verification (MRV) of CO2 emissions; and various transparency and market-based measures. The private sector should focus on decarbonization risk and opportunity analysis (SWOT), disclosure and decarbonization corporate strategies, and internal carbon pricing.

Overall, the environmental regulation in the future will lead to significant changes in the shipping industry. Thus, the industry needs to engage in innovation and Research & Development (R&D) to increase the fleet carbon efficiency and ensure economic success in the future.


***Visual illustrations from the conference***
*Photo: Bjarke MacCarthy*

### Statistical Scenarios and the Obstacles for Investing in LNG, OPS and Scrubbers"

*by Nicola Good, Executive Editor, IHS Fairplay*

At the time of the conference, Nicola Good was the Executive Editor of the Fairplay shipping news service of London-based IHS Markit Maritime & Trade. As a journalist and editor, Nicola Good has reported on shipping for more than 20 years. Sadly, in September 2018 IHS Markit's media business decided to close down Fairplay after having been a flagship journal for the shipping industry for 135 years. Today, Nicola Good is Head of Brand and External Relations in Lloyd's Register, a renowned maritime classification society and technical consultancy organization originally founded in London in 1760.

Based on an extensive dataset from IHS Markit Maritime & Trade, Nicola Good focused her presentation on the future of energy efficient shipping and offered a picture of the rate of uptake of scrubbers and alternative fuels (LNG and onshore power supply).

***Nicola Good, Executive Editor, IHS Fairplay***
*Photo: Bjarke MacCarthy*

The number of vessels that were LNG fueled stood at 242 in 2017, and investments were moderate with only 30-40 new vessels a year. The ordered vessels mainly consisted of containers (25), followed by tankers (23) and offshore vessels (23). It should be noted that at the time of the conference only a few container ships with LNG fuel were operating. The pattern for currently operating vessels is similar to the ordered vessels, where offshore (80) leads followed by ferries (57) and tankers (32). Europe is leading in the LNG market as it has 58 of the 85 ports worldwide that have already installed LNG bunkering facilities or have explicit plans to do so. Overall, the market starts to adopt LNG fuel at a moderate speed.

However, the picture for scrubbers was different at the time: Scrubbers have been on the market for a while, but the industry remained difficult to convince for a very long time. In 2017, there were 416 vessels operating with a scrubber exhaust. Roll-on/Roll-off (Ro-Ro) vessels and Cruise ships are leading the segment with containerships in third place. Given the historically slow adoption of scrubbers and the skepticism of the shipping industry, Nicola Good did not expect to see any major shift in demand for scrubbers. But things have changed since "The Maritime Industry 2030" conference, and there was a large increase in the uptake of scrubbers from the second half of 2018 until end 2019. Some major skeptics changed their stance towards scrubbers: Maersk announced back in 2018 that they would not use scrubbers to comply with the IMO 2020 sulfur cap and yet today Maersk is investing heavily in the exhaust gas cleaning systems.

The market for onshore power supply (OPS) has also emerged as a result of regulation, especially regulation in North America. 232 vessels were fitted with OPS systems in 2017 – led by container ships (131) and followed by cruise ships (54) and Ro-Ro vessels (29).

Overall, 7.4% of the shipbuilding order books in late-2019 were for vessels with alternative compliance options – Scrubbers (1.7%), LNG (4.3%) and gas ready (1.4%). LNG had the highest market share amongst the alternative compliance options, but its further growth depends on the continued installment of the needed infrastructure. Cruise shipping is the dominant segment (27%) to use alternative compliance. However, it is difficult to predict future movements in the market as it hugely depends on the oil price, advances in the technologies, and regulation.

### "The Business Case for Sustainably Exploiting Ocean Resources"

*by Marjolein van Noort, Freelance Maritime Expert*

Marjolein van Noort is Senior Policy Advisor for the Dutch shipowners' association "Koninklijke Vereniging van Nederlandse Reders (KVNR) and Freelance Maritime Expert on Sustainable Innovation. She is the Chairman and Board Member of Our Oceans Challenge, a foundation

that aims for a sustainable offshore industry through collaboration by all industry partners. She has a long background in working with both the government and the maritime industry. The state of the oceans has been part of her focus area for the last couple of years, varying from seaweed to plastic and from vessel design to value chain cooperation. As a freelance advisor, she focuses on entrepreneurship in a maritime context and the connection between government, companies, NGOs and entrepreneurs. Marjolein van Noort has a master's degree in Economics and Business Administration from the University of Amsterdam.

In her presentation at "The Maritime Industry in 2030" conference, Marjolein van Noort explained the reasoning behind and approaches for a successful and sustainable exploitation of ocean resources. She argued that population growth in combination with the fact that 70% of the world surface is ocean, leads to the need to exploit the ocean resources. Sustainability in exploitation is needed to ensure that also future generations can use the ocean resources in the same way as we can.

However, several aspects are important to create a sustainable and economic exploitation of the oceans: Companies need to be innovative to achieve a sustainable exploitation as today's exploitation is too unsustainable. Marjolein van Noort stressed the following points for companies to become more innovative: Firstly, they should learn across the whole supply chain to ensure finding synergies with old knowledge. Secondly, they should create experimental zones to understand knowledge flows and technical spillovers. Thirdly, new models need to be created as the environment becomes too dynamic for traditional business models and economic theory. Lastly, companies should look at combined sources of energy for environmental sustainability and not just rely on one source of energy.

However, sustainable exploitation of the oceans and seas goes beyond innovation, since a company has to look at certain things from a different prospective. For example, materials once thought as only ingredients can also serve as food (e.g., seaweed). Additionally, Marjolein van Noort emphasized the need for the industry to explore and exploit synergies between existing maritime knowledge and new talent in the industry.

Overall, the innovation and perspective change aim to align sustainability with economic performance as the companies have to remain profitable throughout the process of changing their business model to a more sustainable one. It is especially challenging for the companies to integrate new technology to the existing systems. Moreover, the implementation and enforcement of environmental regulation imposes an immense challenge to the industry. Firstly, it is multi-dimensional: emissions, oil pollution, ballast water etc. Also, skepticism against regulatory enforcement induces a free rider problem, as environmental innovation will not necessarily lead to differentiation. A solution would be to increase data transparency to track emissions and set monetary incentives to reduce emissions.

Overall, a shift to sustainable business models is needed in the maritime industry and this require corporate entrepreneurship and innovation that take into account the systemic nature of the sustainability challenge. Once the perspective on innovation, usual business and regulation has changed, the maritime industry will increase its contribution to the sustainable economy.

# UNIVERSITY-INDUSTRY COLLABORATION

**"Potential and Challenges in Industry-University Collaboration"**
*by Bo Cerup-Simonsen, Managing Director, Danish Hydrocarbon Research and Technology Centre*

From 2014 to 2019, Bo Cerup-Simonsen was Managing Director of the Danish Hydrocarbon Research and Technology Centre, which was established as part of a national strategy to increase recovery of oil and gas in the Danish part of North Sea. He has worked in a large number of boards and committees and has held leading positions in Det Norske Veritas (now DNV GL), Maersk Maritime Technology (MMT), and Royal Caribbean Cruises, Ltd. Today, he is the director of the recently established Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Bo Cerup-Simonsen holds a PhD in Mechanical Engineering (Naval Architecture and Offshore Engineering) from the Technical University of Denmark (DTU), where he also worked as an Associate Professor until 2003. In addition, he is Executive MBA graduate in Shipping and Logistics from Copenhagen Business School (CBS).

In his presentation at "The Maritime Industry in 2030" conference, Bo Cerup-Simonsen elaborated on the potential and challenges of industry-university collaboration. In his opinion, there is a great yet untapped potential for such collaboration in the maritime industry. The long history of the industry and the universities in creating value for society is the foundation to his optimistic opinion. University is often the well-spring of new technologies as the industry is rarely at the technology forefront. On the other hand, companies implement technological and other breakthroughs and provide money and data to support academic research. However, industry and academia share the challenge of faster changing business models, which requires new concepts and solutions.

***Bo Cerup-Simonsen, Managing Director, Danish Hydrocarbon Research and Technology Centre***
*Photo: Bjarke MacCarthy*

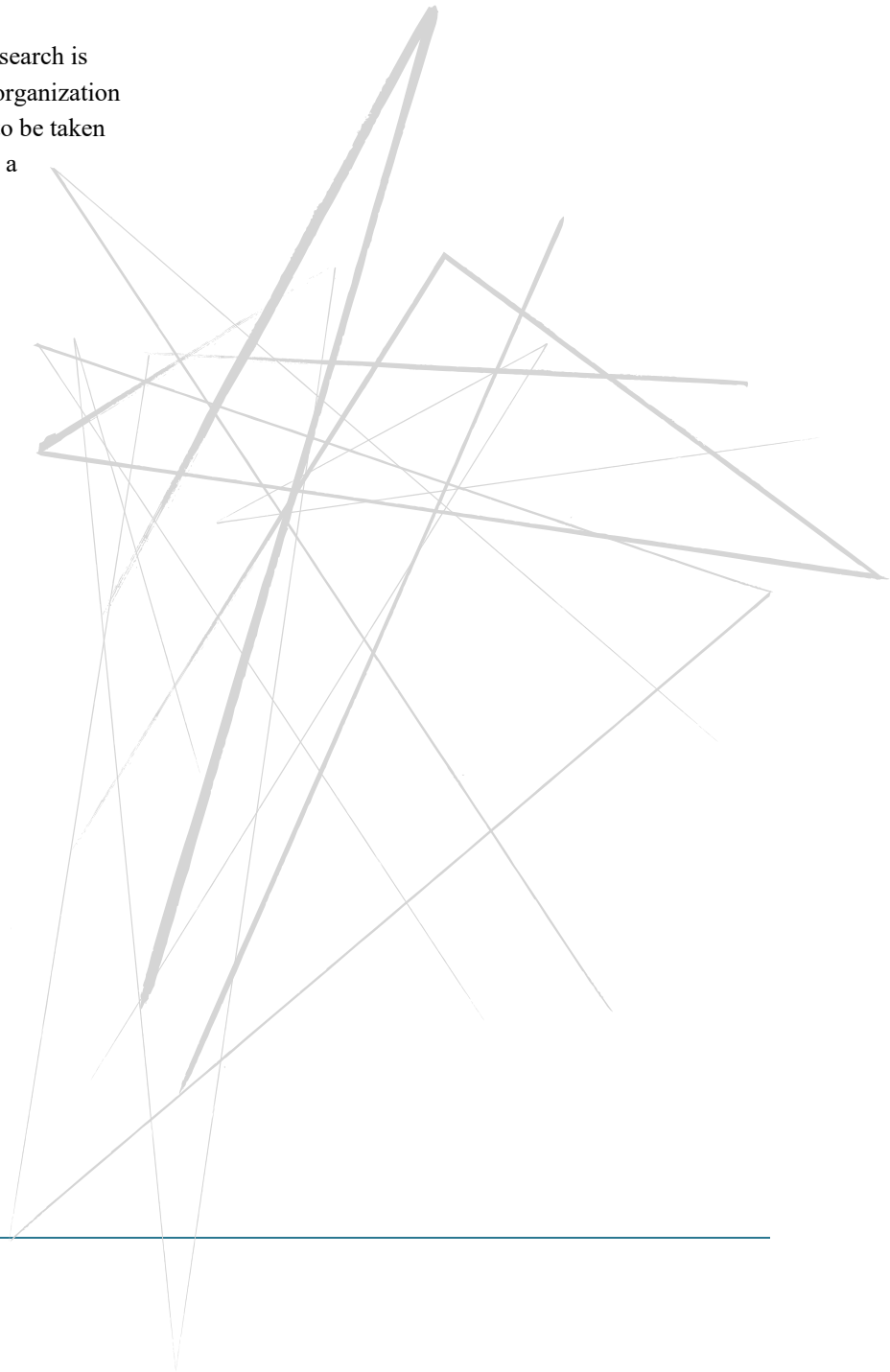
Bo Cerup-Simonsen made clear that he believes in a truly cross-sectoral and cross-disciplinary approach to solve grand societal challenges, such as, the United Nations' (UN) Sustainable Development Goals (SDG). The combination of off-the-shelf solutions and new developments with an iterative "emerge and mature" approach will lead to big solutions, in his opinion.

Successful collaboration needs a good organizational setup and the alignment of goals to unlock the full potential. A successful collaboration needs clarity about the following topics: Objective, timeline, data, engagement between university and industry, common language, how to decide what to do, and when to stop. Furthermore, it is crucial to achieve a shared vision: Is the "big picture" more important, or detail orientation? What level of accuracy of information is enough for each discipline to qualify the concept? Additionally, bigger research projects also always require the intrinsic motivation of all members, so autonomy, mastery and purpose are also important for the success of industry-university collaborative projects. A balancing point for the research project is autonomy and collaboration, which has to be solved for each research project individually. However, the mindset and culture of

the participants also play a crucial role. All these questions have to be addressed for each collaboration individually to ensure the success of the project.

Furthermore, companies and universities have to recognize the complexities and differences between Technology Readiness and Implementation Readiness. Companies usually desire technological readiness of universities' research but neglect the importance of implementation readiness. However, implementation readiness determines the economic success of a technology for the individual company. Implementation readiness entails many different dimensions: Organization (the people and the supply chain), Business Model, Regulation. As a result, companies should also consider the implementation readiness of the new technology, while research could address the issue of implementation readiness and increase knowledge about it.

Overall, the potential for industry-university research is tremendous, but the requirements towards the organization setup and the mindset of the participants have to be taken into account and should be addressed to ensure a successful collaboration.



# RESEARCHERS' WORKSHOP AND STEPS AHEAD



The presentation of Bo Cerup-Simonsen gave a good overview of opportunities and obstacles for collaboration between industry and university, but further discussion of this important topic is needed. With this final section we will inform about the researchers' workshop on the second day of the "Maritime Industry 2030" conference and elaborate on important aspects of university-industry collaboration as well as the differences between interdisciplinary and multi-disciplinary research. The section concludes with reflections on the role of the "Coordinator" in research collaborations. The discussion aims to assist the MRA implement research collaborations in the future and trigger possible discussions at the start of research collaboration to avoid costly mistakes in the setup of the collaboration.

The researchers' workshop on 6th of February, the second day of the conference, was an opportunity for the more than 50 participating faculty and staff of the Danish universities and maritime schools with an interest in maritime-focused research, development and innovation (RDI) to discuss in more detail the important issues facing this particular industry. The aim of the workshop was to discuss in particular the topics of the preceding day to identify and develop ideas for collaborative research projects. The researchers' workshop was guided by the Copenhagen-based strategy, learning and design agency Bigger Picture. They organized the process of discussion, facilitated the communication within the (cross-disciplinary) groups established across the universities and academies, and gave important feedback and input when needed.

To initiate discussions the participants divided into five cross-disciplinary groups of researchers, based on research interests and field of expertise. The five groups were:

1. Digitalization (incl. Autonomous Systems)
2. Decarbonization
3. Connectivity, Trade Facilitation, and Supply Chain Efficiency
4. Governance
5. Innovation and New Maritime Technology

The topics of the groups were similar to the presentations of the preceding day to find potential overlaps between the need of the industry and research ideas. The groups' task for the day was to discuss the topic and propose a research idea advanced from that topic to all the researchers participating in the workshop.

The groups came up with a number of more or less well-defined ideas, and there were some minor overlaps of ideas coming from the different groups. Using visualizations drawn on posters, each of the groups presented at least one of its identified ideas to the other workshop participants, and participants subsequently voted to rank all the ideas (it was not allowed to vote for one's own idea). The proposed research projects and the voting afterwards provided an interesting look into what the maritime academic research community in Denmark currently considers important research problems and approaches to solve them.

The proposed projects and the voting clearly showed that three major themes currently are considered as most important:

1. Automation
2. Digitalization and data driven growth
3. Decarbonization and green transition

These three selected research themes have subsequently been chosen as key areas for cross-disciplinary, collaborative research projects to be developed and carried within the MRA.

## COLLABORATION WITH THE INDUSTRY

Individually, universities and industry create value for society. However, collaboration between industry and academia has the potential to increase the gains for society. The phenomenon of a university-industry collaboration is relatively recent, as such types of collaboration were infrequent before 1990 (Ankrah & Al-Tabbaa, 2015). Hence, our knowledge about the determinants of successful industry-university collaboration is partial and fragmented, although the existing literature delivers some reoccurring themes. We will discuss these in the following.

In general, industry-university collaboration is the result of the pressure on universities to increase their contribution to society beyond the sharing of knowledge to a more economic contribution (Pertuzé et al., 2010). Academics have the opportunity to work closely with industry with the incentive to generate applicable research and publications. Moreover, universities can generate additional income streams with relatively little bureaucracy, while enhancing their university's prestige. Industry-university collaboration also offers the opportunity for a stable testing, training and placement of students as well as for professors.

On the other hand, the incentive for the industry is amongst other things the access to knowledge and the research facilities of the universities and the implementation of this knowledge to generate economic gains. Furthermore, the industry can potentially get access to students to hire them in the future as well as to engage professors as consultants. Additionally, the efficiency of processes can be improved in stable surrounding. As a result, the incentives and goals of the universities and the industry are not naturally aligned. Therefore, a good setup and governance is needed to ensure the success of the collaboration.

Unfortunately, industry and academia struggle to reach a successful collaboration as only 50% of the projects in a MIT study had a good outcome for the researchers and only 40% of these had an impact on the collaborating company – the so-called "outcome-impact gap" (Pertuzé et al., 2010). The remainder of this section gives an overview of possible measures to prevent such shortcomings.

It is important to note that each collaboration is highly individual and the barriers for a successful collaboration also vary for different sectors (Bruneel, et al., 2010). In general, the right organizational form should be picked to ensure a successful collaboration. In particular, Bruneel et al. (2010) mention the following collaboration forms: personal, informal relationships (e.g., information exchange forums); personal, formal relationships (e.g., joint supervision of PhDs and Master theses; third party (e.g., institutional consultancy); formal targeted agreements (e.g., contract research); formal non-targeted agreements (e.g., endowed chairs and advisory boards); and focused structures (e.g., innovation/incubator centers). With the extend of the collaboration not only the financial or resource commitments increase, but also the level of organizational involvement. Some patterns seem important in all of these kinds of collaboration:

1. The communication between the industry and the university research team should be strong and frequent (Pertuzé et al., 2010). Communication appears to be one of the most important mitigations to the risk of a research collaboration, in particular communication about deviations from the mission. Possible activities during the university-industry collaboration could be meetings, personal communication and training, to mention just a few (Ankrah & Al-Tabbaa, 2015). The importance of extending communication beyond a small circle of people and involve many people, to assure agreement, must be emphasized. A coordinator can facilitate the communication between both parties. We will discuss this possibility in greater detail below. The literature notes that informal and frequent contacts generally lower the barriers of communication (Bruneel et al., 2010).
2. Closely related to this problem is the breadth of interaction. A higher number of interaction points ensures that the project and team members are

working closely together to ensure that the collaboration does not deviate from its mission. On the flip side, the higher number of interactions is a burden and costs resources (Bruneel et al., 2010). As a result, the optimal breadth of communication depends highly on the specific collaboration.

3. A high level of trust amongst the university and industry staff is needed to ensure success of the project. As research projects have highly uncertain outcomes, it is important to assure that both partners put in the promised effort and not try to take advantage of the other partner.
4. Another important feature of a successful research collaboration is that it is usually a long-term collaboration. The average time of a successful research collaboration, according to Pertuzé et al. (2010), was 2.5 years. The reason is that the mutual understanding of the university and industry staff increases over time. Also, the communication and trust will improve over time. Therefore, chances are that over time a research project will become more successful, but the length of the project should always be adjusted to specific needs.
5. Moreover, the company should ensure a broad awareness for the project within the company. Thereby, the company assures that potentially company staff beyond the project members may give valuable input on the project to potentially achieve a higher impact on the company as well as a useful idea to the research team (Pertuzé et al., 2010).

Until now, we only covered the part of the discussion about the process of the actual research. However, research projects need to yield actual results to have an impact on the company as well as the research of the university. The next step is to explain how results can be delivered from universities and used by the industry after the research project is completed. One important aspect is that the company also invests into the research project after the project was completed. The investment usually involves the time of the project manager, who is responsible for ensuring that that the findings of the research projects find a suitable application within the company. This investment will increase the impact of the research project and its results on the company significantly (Pertuzé et al., 2010).

There are several opportunities to exploit the results of a research project. Depending on the nature of the project, different tools are needed to maximize the impact of the research on the company. Technical projects will need to ensure that they gain exclusive rights to use the new technology by patenting, or Intellectual Property Rights (IPR). Another way is the implementation of the tools developed during the research collaboration. Furthermore, the esteem of a research project and its findings can be augmented through press releases. A last important measure to increase the impact of the findings of the research collaboration is the use of regular meetings and agreements. Thereby, the close connections between the academic research team and the industry project members remains intact and possibly new research projects can be established. Additionally, the academic research members can update the company about the new trends within the research field, while the industry project members can inform the academic research team about the current needs of the industry.

Overall, the importance of the delivery of the results must be stressed as it is fundamental to impact.

## INTERDISCIPLINARY VS. MULTI-DISCIPLINARY RESEARCH

As the complexity of problems increases, the solutions also become more complex and are often not possible to solve from within an individual research field. Therefore, the solutions to these problems need to also become more multidimensional and more multidisciplinary. But the potential gains from a multidisciplinary research collaboration come at a cost. The different research areas are likely to have little or even no mutual understanding, and it can be challenging and time consuming to reduce these barriers and speak “one language”. This process is burdensome, and the outcome is highly uncertain, which could be a potential reason for researchers to not engage in such a research collaboration. However, the results of a multidisciplinary approach can yield solutions to more complex solutions and therefore yield a higher impact on society, reputation and future funding (Burmeister et al., 2017).

A possible countermeasure is to make the collaboration meaningful. This aspect is even more important for multidisciplinary research groups than for interdisciplinary research groups as not only the initial burden has to be carried, but also it must be meaningful across disciplines so that all the involved researchers are willing to carry the initial burden (Burmeister et al., 2017).

Teamwork within a multidisciplinary setting can also differ from teamwork in an interdisciplinary research group. For example, some disciplines might just work in the beginning of the research project and then other disciplines take over to realize the plan. Therefore, the communication between some research groups might be not as burdensome as may be expected (Burmeister et al., 2017).

## THE COORDINATOR

"The Coordinator" in a research collaboration has an important role for the success of the project, as the coordinator is responsible for the coordination and organization of the project as well as the impact of the research collaboration on industry or the individual company.

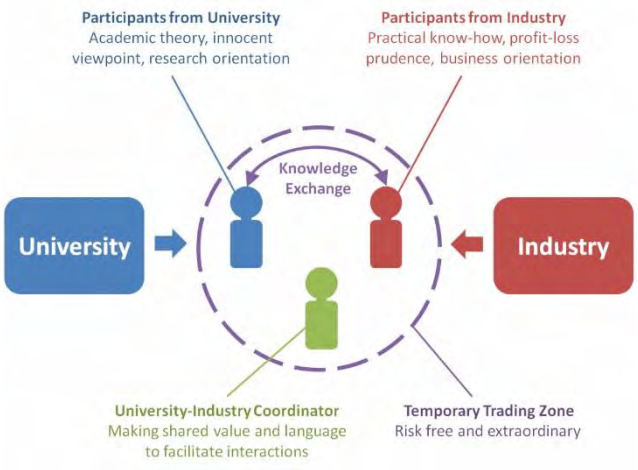
Therefore, the requirements towards the coordinator are rather high. The coordinator is responsible for raising awareness for the project in industry or within the individual company by engaging with industry representatives and company employees working in positions of relevance the project. This also allows the coordinator to obtain firsthand, important input from industry and company representatives. In particular, industry representatives and company staff members can potentially provide interesting ideas for the research project and accelerate the project. Furthermore, especially company staff can give feedback about possible implementation in their company unit (Pertuzé et al., 2010).

The coordinator is also important for the research team. Not only does the coordinator return valuable ideas about the possible implementation of project outcomes, but also potentially valuable ideas about the project itself. The academic research team can then use this feedback as an input to its work and increase efficiency as well as the impact of their research (Pertuzé et al., 2010).

From the above stated "job description", there are two main requirements to the coordinator. Firstly, the coordinator should be an outgoing kind of person with a wide network in the industry to ensure a good communication. Secondly, the coordinator must have a high technical understanding of the research project. Thereby, the coordinator can approach the right industry representatives or company employees, follow their feedback regarding potentially new ideas and implementation opportunities, and give the feedback towards the academic research team and other project members (Pertuzé et al., 2010).

A final important point relates to the coordinator's experience with industry-university research collaborations. A good planning of the research collaboration can potentially avoid problems that occurred in previous research collaborations. Furthermore, routines learnt during previous research projects can be reused and redefined to ensure the success of the research collaboration (Bruneel et al., 2010).

A good visualization of the coordinator is found bellow: It shows the role of the coordinator to facilitate the cooperation between the university and industry. It also indicates that the coordinator is responsible to create a risk free and comfortable zone for both parties, so they can cooperate the best possible for them.




***Source: Nakagawa et al. (2017), p. 47***

# APPENDIX 1 – NOTES FROM CONFERENCE AND RESEARCHERS´ WORKSHOP

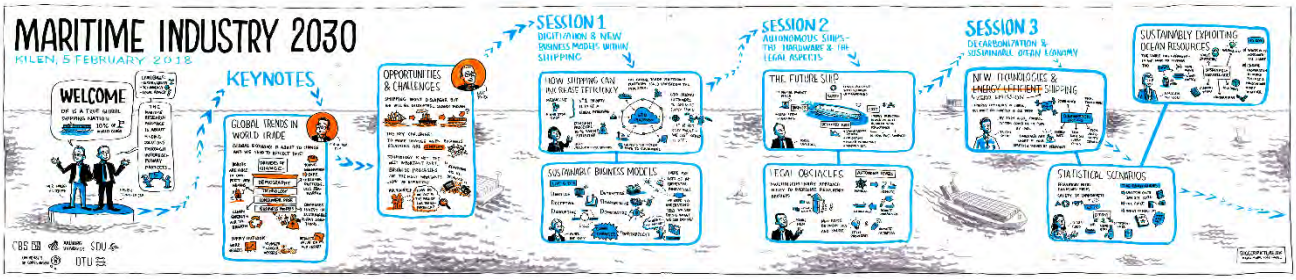
| Societal Context | Digitalization | Education and Training | Autonomous Vessels | Decarbonization |
|---|---|---|---|---|
| Recommendations (Maritime Strategy Team) | Overcome fragmented and conservative nature | More data training; Higher international cooperation | | |
| Navigating Challenging Waters (Danish Maritime Forum) | Promote to ensure efficiency gains and remain competitive; ease burden for start-ups | More training to ensure competitive edge | | |
| Vallleta Declaration (EU) | Ensure efficiency gains; also digitalize regulatory bodies; simplify regulation; better use of data and more data sharing | Need more talent in the sector; Increase attractiveness for the sector; more employment of women | | |
| The Ocean Economy in 2030 (OECD) | Regulation difficult due to fast changes; inadequate or lack of data major issue; high potential for data analytics and machine learning | Also train the population; Encourage further research | Good circumstances to produce a ship | Ecological system as underlying asset to economic activity; 2-3% of CO2, 5-10%of Sox, 17-31% of Nox |
| Digitalization of Seaports (Hamburg Port Authority) | Share best practices within the network to promote innovative solutions | | Coexistence with nowadays vessels; will change the landscape of the industry significantly | |
| Global Marine Technology (Lloyd's, QineticQ, University of Southhampton) | | Automatization changes required skill in the industry | | |
| Technology Outlook 2025 (DNV GL) | | | Will enter industry soon | |
| Autonomous Ships on the high sea (Oskar Levander) | | | Reduce wind resistance; More space for cargo; no risk of pirates; more attractive labor force; less errors | |

| **Societal Context** | Alternative fuels | Fishing | Ocean Monitoring | Ocean Acidification | Ocean Power |
|---|---|---|---|---|---|
| Valleta Declaration (EU) | Encourage LNG to reduce Sulphur emissions | Global warming threats fish stock; stagnating fishing | | | |
| The Ocean Economy in 2030 (OECD) | Difficult to enforce good environmental regulation | | Understand the strong interdependencies | Ocean absorbs Carbon leading to acidification; different migration patterns of fishes and less biodiversity | Small capacity but huge potential |
| Digitalization of Seaports (Hamburg Port Authority) | LNG Sulphur free emission | | | | |
| Assessment of selected alternative fuels and technologies (DNV GL) | Sulphur content set to 0.5% worldwide by 2020; LNG bunkering expand rapidly | Depends on healthy and productive ecosystem; aquaculture can close demand gap | | | |
| The Future of the Ocean Economy (OECD) | | | Unreported fishing is a major problem; greater international cooperation is needed; better data will lead to better regulation | | Supply chain limits might hurt growth; tidal barrages also advanced; others at demonstration stage |

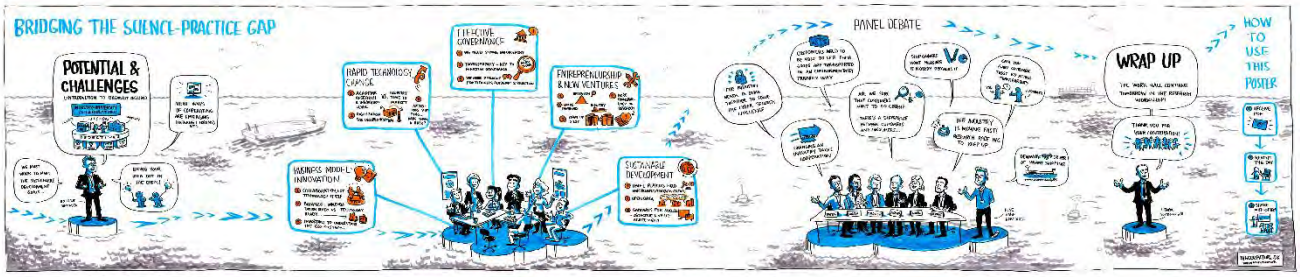
# APPENDIX 2 – VISUAL ILLUSTRATIONS OF THE MAIN TAKE-AWAYS

TO PROCESS THE COMPLEXITY OF THE MANY DIFFERENT CHALLENGES AND OPPORTUNITES FACING THE MARITIME INDUSTRY, WHILST PICKING UP IDEAS AND INPUTS FROM THE CONFERENCE AND FACILITATING THE FOLLOWING WORKSHOP, THE ORGANIZERS WERE SUPPORTED BY LEARNING AND DESIGN AGENCY, BIGGER PICTURE.

BELOW ARE THEIR VISUAL ILLUSTRATIONS OF PRESENTATIONS AND DISCUSSIONS.




*Bigger Picture Aps.*




*Bigger Picture Aps.*


*Bigger Picture Aps.*

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# CBS MARITIME:
# INTERDISCIPLINARY RESEARCH AND KNOWLEDGE FOR SOCIETY

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